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ecoENERGY
an ecoACTION initiative

Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2006–2007

Canada

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Publishing by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*
pour l'année financière 2006–2007

Cat. no. M141-10/2007E (Print)
ISBN 978-0-662-47293-3

Cat. no. M141-10/2007E-PDF (Electronic)
ISBN 978-0-662-47294-0

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Minister's Foreword

I am pleased to introduce this Report to Parliament. Fiscal year 2006/2007 was a year of decisive action on energy policy and programs by our Government.

Canadians have made it clear that the health of our environment is a top priority, and our Government is responding with real action to address key concerns including climate change and air pollution.

Our ecoENERGY Initiatives are achieving real results for Canadians, underlining our commitment to work with our partners in the provinces and territories, in the private sector and with individual Canadians to reduce the emissions that are harmful to both our environment and our health.

Our ecoENERGY Efficiency Initiative is helping Canadians make their homes, buildings, industries and vehicles more energy efficient. We are strengthening and expanding the regulations contained in the *Energy Efficiency Act* to assure Canadians that, whether they are buying a light bulb or a refrigerator, they can be confident it is among the most efficient in the world.

Our ecoENERGY for Renewable Power Initiative will encourage the production of enough clean electricity from renewable sources including wind, biomass, low-impact hydro, geo-thermal, solar photovoltaic and ocean energy, to power about one million homes. We are increasing our supply of cleaner fuels, and creating new economic opportunities for Canada's farmers, with our ecoENERGY for Biofuels Initiative. And, we are supporting the development of new, cleaner-energy technologies with our ecoENERGY Technology Initiative.

These measures, and others like them, are at the heart of our government's practical, balanced approach to addressing climate change and reducing air pollution.

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The largest source of untapped energy is the energy we waste. By investing in real action to increase energy efficiency, increasing our supply of cleaner energy and developing the technologies that will allow us to become cleaner producers and users of conventional energy, we are making real progress toward the results Canadians want; reduced energy costs, cleaner air and a healthier environment for all.

Lisa Raitt

The Honourable Lisa Raitt, P.C., M.P.
Minister of Natural Resources

Executive Summary

Canadians spent approximately $152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature, and an economy founded on an abundance of natural resources.

Types of Energy Use

The two general types of energy use are primary and secondary. Primary use comprises Canada's total consumption, including energy required to transform one form to another—such as coal to electricity—and energy required to deliver energy to consumers. Secondary use comprises energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2005, the latest year for which figures are available, primary energy use increased by 27.0 percent.
- In 2005, secondary use accounted for 68.5 percent of primary energy use and produced 66.2 percent (495 megatonnes [Mt]) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumes the most energy, accounting for 37.9 percent of total secondary energy use in 2005. Transportation is second (29.5 percent), followed by residential (16.5 percent), commercial/institutional (13.6 percent) and agriculture (2.5 percent).

Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan uses a broad range of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data about energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency but also impacts such as weather variations and changes in the structure of the economy.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors. However, this growth would have been much greater without improvements in energy efficiency. As reported in Chapter 1, energy efficiency improvements made between 1990 and 2005 are estimated to have reduced GHG emissions by almost 64 Mt and decreased energy expenditures by $20.1 billion in 2005 alone.

Between 1990 and 2005, the residential sector recorded a 24.9 percent increase in energy efficiency. The figures for transportation (18.8 percent), industry (12.8 percent) and the commercial/institutional (8.7 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce their energy bills and achieve important environmental goals. Over the short term, changes to less GHG-intensive fuels (for example, from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

Canada is a world leader in the production of renewable energy with almost 16 percent of its primary energy supply coming from renewable sources in 2005.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector, highlights NRCan's efficiency and alternative energy (EAE) programs, and lists their key achievements for 2006–2007. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format (see below). A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Performance Indicators Highlighted in the Report

Equipment, Standards and Labelling

- Volume of Monthly Import Documents
- Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)
- ENERGY STAR® Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005
- ENERGY STAR Awareness Levels in Canada, 2005

Housing

- Annual Heating Consumption for Houses Constructed to Different Standards
- Number of Households, Average Floor Space of New Houses and Energy Intensity Indexes, 1990 to 2005
- Average Energy Consumption of New Appliances, 1990 and 2005 Models
- Number of Eligible R-2000* Housing Starts, 1990 to 2006
- Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007

Buildings

- Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2006
- EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2006

* R-2000 is an official mark of Natural Resources Canada.

Industry

- CIPEC Energy Intensity Index, 1990 to 2005
- Estimated CIPEC Energy Savings, 2001 to 2006
- Industrial Dollars to $ense Participants, 1997 to 2006

Transportation

- Company Average Fuel Consumption (CAFC) versus Canadian Voluntary Standards, 1990 to 2006
- Vehicle Fuel Efficiency Labelling
- Drivers Trained, 1998 to 2005

Renewable Energy

- Electricity Generation Capacity from Renewable Sources (Includes Hydro-Electricity)
- Canadian Wind Power Capacity, 1993 to 2006
- REDI for Business Projects Completed, 1998 to 2005

Federal House in Order

- GHG Emissions Reductions From Federal Operations, 1990 to 2010
- Federal Fleet Size and Fuel Consumption, 1997 to 2005
- Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2005

Introduction

NATURAL RESOURCES CANADA'S EFFICIENCY AND ALTERNATIVE ENERGY PROGRAM

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (that is, alternative transportation fuels and renewable energy) as a means to reduce greenhouse gas (GHG) emissions and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2006–2007 is in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use—that is, to the consumption of energy in the residential, commercial/institutional, industrial, and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research, development and demonstration (R,D&D) initiatives
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and cooperation with stakeholders such as other levels of government, the private sector and non-governmental organizations. With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of energy production.

POLICY INSTRUMENTS

NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research, development and demonstration

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

FIGURE INT-1

Moving the Market

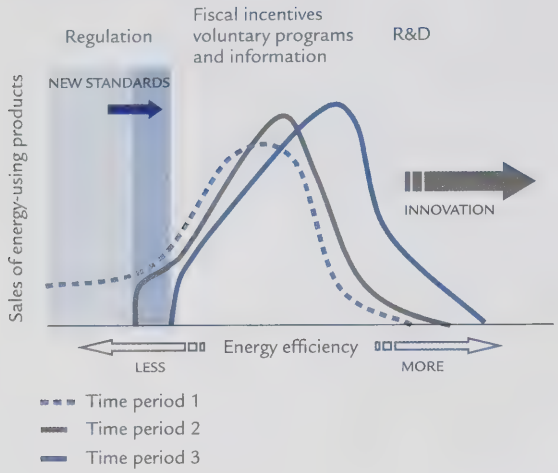


Figure Int-1 shows how these policy tools work together to increase energy efficiency, that is, how they help to reduce the amount of energy needed to obtain a certain level of service. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information increase the take-up of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving higher levels of efficiency in a particular type of energy use.

Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations, primarily for establishing performance and labelling requirements for energy-using products and doors and windows that are imported or shipped across provincial borders.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants, natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free telephone lines, conferences, Web sites, workshops, training, building design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan voluntarily to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, setting energy efficiency targets. NRCan provides support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

Research, Development and Demonstration

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies, and alternative energy technologies. R,D&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking research in its own laboratories, contracting research activities to other organizations and carrying out the federal funding initiatives listed in Chapter 9. These initiatives are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

MEASURING PROGRESS

The primary goal of NRCan's EAE initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

NRCan monitors and tracks the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes**—namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Since program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome leading to a market outcome is a householder's purchase of a more energy-efficient appliance, resulting in reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

DATA COLLECTION AND ANALYSIS

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support NRCan's analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities. However, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of energy use in the transportation, industrial, commercial/institutional and residential sectors. The surveys gather information about the stocks and characteristics of energy-using equipment and buildings, observing Canadians' behaviour with respect to energy use, monitoring the adoption of new technologies in the marketplace. In 2006–2007, the NEUD initiative sponsored the collection of energy data in the commercial, transportation and industrial sectors, analyzed this data and produced reports that explain how and where energy is used in each sector. Work was also initiated to collect energy data in

the residential sector in 2007–2008, which will also form the basis for a report. The NEUD initiative also produced a comprehensive energy use database with accompanying publications to explain Canada's overall energy use and energy efficiency trends. All NEUD initiative reports are available to the public, free of charge, both in hard copy and on-line.

The NEUD initiative also has participated in the development of energy end-use data and analysis centres (DACs) across Canada. Three DACs currently exist: the transportation centre at Université Laval in Québec City, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta. The DACs are mandated to improve the accessibility and comparability of existing data about the evolution of energy consumption and its impact on environmental quality.

GHG EMISSIONS AND CLIMATE CHANGE

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of cooperation among all nations.

IN THIS REPORT

This fourteenth annual *Report to Parliament* focuses principally on EAE initiatives that address secondary energy use. The EAE programs described in this *Report* were operational for the 2006-2007 fiscal year. Some of the programs have continued, while others have since been completed. The ecoENERGY programs described within this document were initiated on April 1, 2007 and will continue for the next four years. Trends in energy use and GHG emissions in Canada are discussed in Chapter 1. Chapter 2 discusses the equipment regulations under the *Energy Efficiency Act* and equipment labelling activities. Chapters 3 to 6 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 7 deals with renewable energy sources and use. Chapter 8 describes the Government of Canada's actions to improve its own use of energy. Chapter 9 describes general programs that are not specific to the EAE initiatives discussed in Chapters 3 to 7. The final chapter describes domestic and international cooperation in EAE. Appendix 1 contains information about NRCan's EAE expenditures. Appendix 2 contains detailed information about the figure data presented in this report.

ecoENERGY PROGRAMS 2007/2008 – 2010/2011

ecoENERGY for Industry – is designed to improve industrial energy intensity and reduce energy-related industrial GHGs and air pollution. The program is delivered through the long-standing and successful Canadian Industry Program for Energy Conservation (CIPEC), a voluntary partnership between the Government of Canada and industry that brings together industry associations and companies representing more than 98 percent of all industrial energy use in Canada.

ecoENERGY for Biofuels – will invest up to $1.5 billion over 9 years to boost Canada's production of renewable fuels such as ethanol and biodiesel. As a key element of the government's comprehensive strategy on renewable fuels, this program will make investment in production facilities more attractive by partially offsetting the risk associated with fluctuating feedstock and fuel prices.

ecoENERGY for Personal Vehicles – offers easy access to information, including fuel consumption guides and other decision-making tools, to help Canadians choose the most fuel-efficient car or truck for their particular needs. This initiative will also work with communities, provincial and territorial governments and other partners to encourage driving and vehicle maintenance habits that increase fuel efficiency, reduce emissions and save money.

To make sure Canadians continue to enjoy a wide selection of fuel-efficient vehicles, the Government is working directly with automakers to reduce GHG emissions by 2010. This voluntary effort by automakers will support mandatory fuel-efficiency regulations that will come into force for the 2011 model year.

ecoENERGY Retrofit – provides financial support to homeowners, small and medium-sized businesses, public institutions and industrial facilities to help them implement energy saving projects that reduce energy-related GHGs and air pollution, thereby contributing to a cleaner environment for all Canadians.

ecoENERGY for Buildings and Houses – is designed to encourage the construction and operation of more energy-efficient buildings and houses using complementary activities such as rating, labelling and training. Energy efficiency makes for healthy workplaces and living spaces, increases comfort and saves money.

ecoENERGY for Fleets – introduces fleets to energy-efficient practices that can reduce fuel consumption and emissions. This program offers free practical advice on how energy-efficient vehicles and business practices can reduce fleet operating costs, improve productivity and increase a fleet's competitiveness.

Along with the latest developments in fleet and fuel management, ecoENERGY for Fleets will also help ensure fleet vehicle owners and managers are aware of the fuel efficiency benefits of new and developing technologies. On the education side of the initiative, it is expected that more than 200 000 professional drivers — of heavy trucks, buses, construction and other vehicles — will receive training in energy-efficient vehicle-operating techniques over the next four years.

ecoENERGY for Renewable Heat – will invest $36 million over four years to increase the use of renewable thermal energy, help develop renewable thermal energy industry capacity and contribute to cleaner air by displacing fossil fuel-based energy use for space heating and cooling and for water heating in Canadian buildings.

Under the program, a solar deployment incentive of 25 percent of project cost targets the industrial, commercial and institutional sectors. Industry capacity development funding is available to support the solar and geoexchange industries in upgrading standards and training installers. And a large-scale residential sector deployment pilot initiative will work with utilities and developers to deploy thousands of solar domestic water-heating systems across Canada.

ecoENERGY for Renewable Power – will invest $1.48 billion to increase Canada's supply of clean electricity from renewable sources such as wind, biomass, low-impact hydro, geothermal, solar photovoltaic and ocean energy.

An incentive of one cent per kilowatt hour to eligible low-impact, renewable electricity projects will encourage the production of 14.3 terrawatt hours of new electricity from renewable energy sources. This represents about 4000 megawatts of new capacity, enough electricity to power approximately 1 million homes.

ecoENERGY Technology Initiative – will fund RD&D to support the development of the next-generation clean-energy technologies to increase the clean energy supply, reduce energy waste and reduce pollution from conventional energy sources. Examples are technologies for clean-coal, carbon sequestration and the reduction of the oil sands' environmental impact; and new end-use technologies, such as hydrogen and fuel cells and energy-efficient buildings and industry. The initiative will also develop technologies for producing and using renewable energy from clean sources such as wind, solar, tidal and biomass.

For more information: **ecoaction.gc.ca**

CHAPTER 1

Trends in Energy Use

INTRODUCTION

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It has also fostered the development of industries that have a particularly strong energy demand.

Canadians spent about $152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, vehicles and industrial processes. This amount represents 14.2 percent of the country's gross domestic product (GDP).

ENERGY USE AND GREENHOUSE GAS EMISSIONS

Energy use is categorized in two general types: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (for example, coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 27.0 percent between 1990 and 2005, from 9740 petajoules (PJ) to 12 369 PJ.

Secondary energy use (8475 PJ) accounted for 68.5 percent of primary energy use in 2005. It was responsible for 66.2 percent (495 megatonnes [Mt]) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions are included—namely, those produced by electric utilities to meet end-use electrical demand.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). CO_2 accounts for most of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2005, secondary energy use increased by 21.9 percent and related GHG emissions increased by 21.5 percent. The GHG intensity of energy changed during the period because fuel switching towards less GHG-intensive fuels offset an increasing energy demand. The industrial sector is the largest energy user, accounting for 37.9 percent of total secondary energy use in 2005. The transportation sector is the second largest energy user at 29.5 percent, followed by the residential sector at 16.5 percent, the commercial/institutional sector at 13.6 percent and the agriculture sector at 2.5 percent.

ENERGY INTENSITY AND ENERGY EFFICIENCY

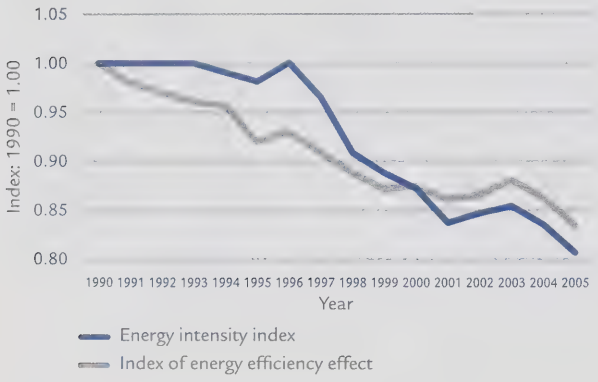
Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple and straightforward and the data for the calculation are readily available. However, this measure is misleading because, in addition to pure energy efficiency, intensity captures impacts such as weather variations and changes in the structure of the economy.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2005. The indexes present improvements in energy intensity and efficiency as a downward trend.

FIGURE 1-1

Energy Intensity and the Energy Efficiency Effect, 1990 to 2005



TRENDS IN ENERGY EFFICIENCY

Every year, NRCan publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- A higher **service level** for auxiliary equipment (for example, computers, fax machines and photocopiers) increases energy use and emissions. During the 1990s, these types of equipment were widely adopted. However, improvements in functionality increased productivity and moderated increases in energy consumption caused by the use of more machines.
- **Energy efficiency** refers to how effectively energy is being used – for example, how long an appliance can be operated with a given amount of energy.

In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use are not captured, this measure of energy efficiency improvement may overstate or understate the "actual" change. For example, in the industrial sector, in an industry such as other manufacturing, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased between 1990 and 2005 (from 6952 to 8475 PJ). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 37.7 percent. However, as a result of a 15.8 percent (1096 PJ) improvement in energy efficiency,[1] actual secondary energy use increased by 21.9 percent to 8475 PJ.

[1] Based on the OEE Index.

TABLE 1-1

Explanation of Changes in Secondary Energy Use, 1990 to 2005

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total**	Percentage change
1990 energy use (PJ)*	1286.2	867.0	2721.8	1877.9	6952.1	
2005 energy use (PJ)	1402.2	1153.0	3209.4	2501.8	8475.1	
Change in energy use (PJ)	115.9	286.0	487.6	624.0	1523.0	21.9
Explanatory factor (change due to)						
Activity	353.1	246.6	1166.0	750.4	2516.1	36.2
Weather	5.5	25.2	n/a	n/a	30.8	0.4
Structure	7.1	-1.2	-331.1	186.8	-138.4	-2.0
Service level	71.0	91.8	n/a	n/a	162.9	2.3
Energy efficiency	-320.9	-75.4	-347.3	-352.4	-1096.0	-15.8
Other factors		-1.0		39.2	47.7	0.7

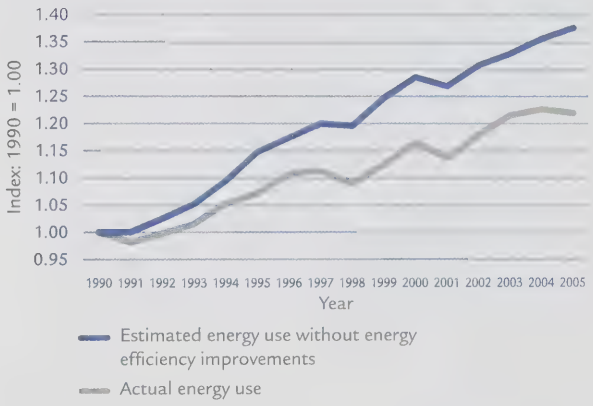
*Petajoules

**Total also includes energy use for agriculture (not shown in "Other factors" in table).

The change in energy use between 1990 and 2005, actual and without energy efficiency improvements, is shown in Figure 1-2. The difference in energy use due to energy efficiency—the estimated energy saving—represents a reduction in energy costs of $20.1 billion in 2005 and a reduction in GHG emissions of almost 64 Mt. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 3 to 6. The energy efficiency improvements were largest in the residential sector (24.9 percent), followed by the transportation sector (18.8 percent), industrial sector (12.8 percent), and commercial/institutional sector (8.7 percent).[2]

FIGURE 1-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



[2] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy-use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of NRCan's *Energy Use Data Handbook, 1990 and 1997 to 2005*.

TRENDS IN RENEWABLE ENERGY

Canada is a leader in the production of renewable energy with almost 16 percent of its primary energy supply coming from renewable sources in 2005. Although renewable energy is often associated with electricity, renewable energy sources also produce thermal energy (steam or heat) or transportation fuels. Renewable energy sources in Canada include water, wind, solar, geothermal and biomass.

Canada has a significant renewable electricity supply due primarily to the widespread use of hydroelectricity. In 2005, 60 percent of Canada's electricity generation was provided by conventional and small hydroelectric plants, which generated more than 358 terawatt hours (TWh) of electricity, up from 337 TWh in 2004. Small hydro plants (less than 50 megawatts [MW]), with installed generating capacity of 3401 MW, provided about 2 percent of the total electricity generated in Canada.

Non-hydro renewable sources accounted for an estimated 2 percent of Canada's total electricity generation. Biomass (waste and virgin biomass and landfill gas) is the main non-hydro renewable energy source in Canada, but wind energy is growing rapidly with an increase in capacity from 139 MW in 2000 to 1459 MW in 2006. Solar photovoltaic has also experienced high rates of capacity growth of about 20 percent annually between 1993 and 2006, although starting from a very low baseline. In 2006, there was a total of 20.5 MW of solar photovoltaic systems installed in Canada, an increase of 3.7 MW over the previous year.

CHAPTER 2

Equipment, Standards and Labelling

INTRODUCTION

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes standards, labelling programs and Canada's *Energy Efficiency Regulations* (the Regulations).

The *Energy Efficiency Act* (the Act) of 1992 gives the Government of Canada the authority to make and enforce regulations on performance and labelling requirements for energy-using products that are imported into Canada or shipped across provincial borders for the purpose of sale or lease.

The *Energy Efficiency Regulations* came into effect in February 1995, after extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. The Regulations refer to national consensus performance standards developed by accredited standards writing organizations such as the Canadian Standards Association (CSA). Such standards include testing procedures that must be used to determine a product's energy performance. Regulated products that fail to meet the minimum performance levels identified in the Regulations cannot be imported into Canada or traded interprovincially.

NRCan works with stakeholders to improve standards development and approval processes and to accelerate the market penetration of high-efficiency residential, commercial and industrial equipment.

Regulations have now been established for more than 30 products that consume 71 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector. Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors of 1 to 200 horsepower and certain lighting products. The Regulations apply to these products even if they are incorporated into a larger unit or machine that is not regulated.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products in situations where the market has been transformed to a higher level of efficiency. The Regulations are also amended to add new products, harmonize minimum energy performance requirements with those of other jurisdictions, and update testing methodologies or labelling requirements. Also, regulations can be established for gathering market data on the energy performance of certain types of equipment. For example, the data gathered for gas fireplaces is used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before amending the Regulations, NRCan conducts studies to analyse how the proposed change will affect the market. For example, NRCan checks if it will have a measurable impact on energy efficiency levels without imposing undue hardship on manufacturers. A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and Regulations, as well as on their practical application in the market.

The Act and the Regulations support labelling initiatives designed to help consumers and commercial/industrial procurement officials identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas (GHG) emissions over the life of the product.

For example, the Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners. For appliances, the EnerGuide label shows the estimated annual energy consumption of the product in kilowatt hours and compares it with the most and least efficient models of the same class and size. The EnerGuide label for room air conditioners indicates the model's energy efficiency ratio and provides a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product (annual fuel utilization efficiency rating for oil and gas furnaces, fireplace efficiency rating for gas fireplaces and seasonal energy efficiency ratio for central air conditioners) is published on the back page of the manufacturer's brochure. The rating information includes a bar scale that compares the model with others of the same size and capacity.

The EnerGuide for Industry Program used the EnerGuide name on labels to encourage the use of off-the-shelf industrial equipment that is more energy efficient, including equipment prescribed under the Regulations. This equipment includes electric motors; dry-type transformers; heating, cooling and ventilation equipment; and certain lighting products. EnerGuide for Industry offered up-to-date product databases, Web-based applications and energy-use information. Equipment buyers are able to use this information to compare the energy performance of products and select the most energy-efficient model that meets their needs.

As well, the Regulations are consistent with, and build on, the ENERGY STAR® Initiative in Canada. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy efficient on the market. Products that are prescribed in the Regulations and are also part of the initiative must meet levels of energy efficiency starting at 10 percent or more above the minimum performance levels set out in the Regulations to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, their efficiencies become candidates for new standard levels.

STANDARDS

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing federal standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world. This practice minimizes the regulatory burden on manufacturers and avoids confusion for consumers.

For example, the performance requirements in the Regulations are similar to those in several Canadian provinces that regulate energy-using equipment that is manufactured and sold within their borders. Although NRCan works closely with provinces to harmonize standards, some provincial regulations can differ from the federal requirements or can apply to other types of energy-using equipment.

Due to the highly integrated North American market, Canada's energy performance requirements for many products are similar to those regulated in the United States (U.S.). As well, Canada's EnerGuide labelling requirements are coordinated with the EnergyGuide labelling program in the U.S.

Harmonization work is also undertaken through the North American Energy Working Group established by Canada, the U.S. and Mexico.

The Asia-Pacific Economic Cooperation (APEC) organization is another important forum for regional cooperation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of the APEC Energy Working Group (EWG). One EWG initiative is to harmonize energy efficiency test methods and conformity assessment

regimes of Asia-Pacific economies that use energy efficiency standards and labels as part of their environmental or energy programs.

NRCan supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission as well as supporting the national and international policy work of the Standards Council of Canada.

COMPLIANCE AND ENFORCEMENT

The Regulations outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use enforcement measures when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the Act prescribes specific enforcement measures when dealers violate the law. Enforcement activities include preventing the importation of non-compliant products to Canada; preventing the sale or lease of non-compliant products in Canada; and fines. Violators can also be fined under the Administrative Monetary Penalty System of the Canada Border Services Agency for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information from energy efficiency reports and import documents. Section 5 of the Act requires that dealers provide energy efficiency reports when they market a new product model. The required information includes the energy performance of each model, the name of the testing agency and the size category, as described in Schedule IV of the Regulations.

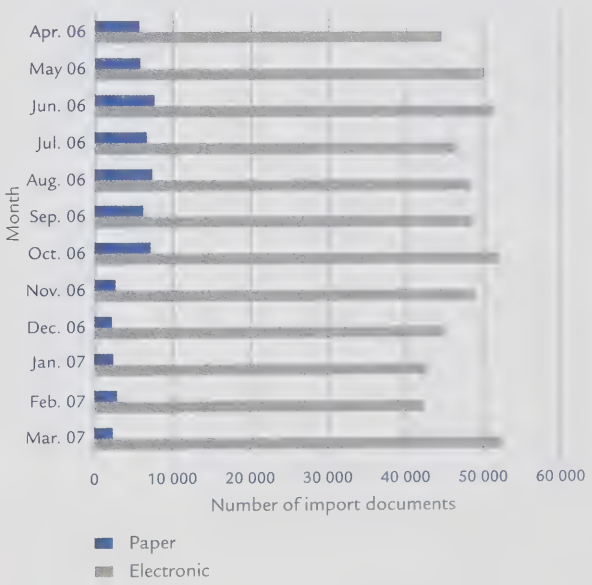
The Regulations require that, when importing a regulated product into Canada, dealers provide specific product information on customs documents for all shipments (type of product, brand name, model number, name and address of dealer and purpose of import). Customs documents contain much less information than an energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan can then verify that all products entering Canada meet the required energy performance levels and can take action when necessary.

Key 2006–2007 Achievements

- NRCan processed over 631 559 records relating to the importation of regulated energy-using products to Canada in 2006–2007. The records were from April 1, 2006, to March 31, 2007. Figure 2-1 illustrates the volume of import documents received in paper form and electronically each month.
- More than 773 621 new or revised model numbers were submitted to NRCan. The records were from April 1, 2006, to March 31, 2007, in energy efficiency reports received from dealers.

FIGURE 2-1

Volume of Monthly Import Documents



REGULATORY IMPACT TO DATE FROM THE REGULATORY IMPACT ANALYSIS STATEMENT

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette, Part II*.

It is estimated that Canada's energy performance standards will cause a reduction of 25.6 megatonnes in aggregate annual emissions by 2010 (see Table 2-1). This reduction is equivalent to taking 4 million cars off the road.

TABLE 2-1

Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)

Product (amendment number in brackets)	Energy savings (petajoules)		CO_2 reductions (megatonnes)	
	2010	2020	2010	2020
Residential appliances	117.20	133.84	13.26	15.60
Lamps – fluorescent/incandescent	11.60	13.40	7.55	9.80
Motors	16.30	17.70	2.03	2.14
Commercial HVAC	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49*	1.10*
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39*	0.94*
Clothes washers, domestic hot water, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (9)	1.64	5.51	0.16	0.55
Total	**178.22**	**241.02**	**25.60**	**34.31**

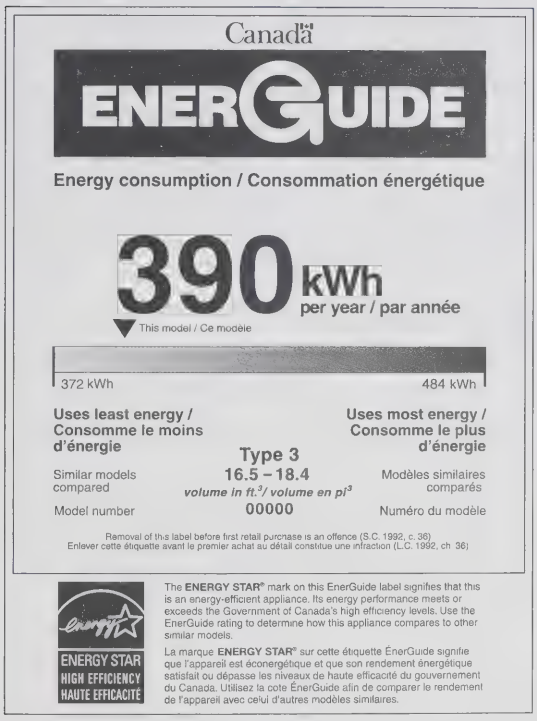
*Values are different from the Regulatory Impact Analysis Statement because of the change in the emission factor (using 99.3).

LABELLING AND PROMOTION

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of appliances. In 1995, with the introduction of the Regulations, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. The label on a product shows how much energy a product uses, allowing the customer to consider the most energy-efficient choice.

FIGURE 2-2

EnerGuide Label



A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, gas fireplaces were added to the EnerGuide rating program. Manufacturers were asked to integrate EnerGuide ratings for fireplace efficiency in their brochures. These changes were coincident with the requirement in the Regulations to test, verify and report on fireplace efficiency.

Because these products are typically purchased from a product brochure or catalogue, prescribing a label on the product is not useful. Manufacturers are encouraged to include an EnerGuide rating in product brochures or catalogues, so consumers can compare the efficiency of the product when they are in the buying process. Major distributors of such products for sale in Canada report the verified energy performance rating of their products, as tested to the standards in the Regulations. The verified energy performance rating corresponds to the EnerGuide rating published in the brochures or catalogue. To date, manufacturers representing 85 percent of the products in the market participate in the EnerGuide rating program and publish the ratings in their brochures. In addition, participants in the EnerGuide rating program must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that can result from labelling.

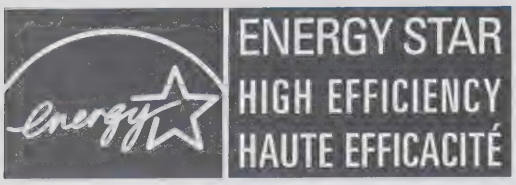
EnerGuide directories that list energy ratings for major appliances and room air conditioners are published annually. They are distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. On-line directories for all appliances and heating and cooling equipment are published on the Web site of the Office of Energy Efficiency (OEE) and updated monthly.

Regularly conducted polls indicate that more than 50 percent of Canadians surveyed are aware of the EnerGuide label.

In 2001, responding to public interest in a labelling system that identifies the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). Canada signed an agreement with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The OEE is the custodian of the program for Canada. Canada was the fifth country to join the ENERGY STAR program, along with Australia, New Zealand, Japan and Taiwan. The European Union adopted ENERGY STAR for office equipment.

FIGURE 2-3

ENERGY STAR® Label



ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected for the technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the admission criteria and performance levels. For appliances and heating and cooling products, the criteria are based on the same test standards as those applied under the Regulations. Canada promotes specific product categories for which levels and criteria can be harmonized with those of the U. S., including the following:

- major appliances
- heating, cooling and ventilation
- consumer electronics
- office equipment
- windows and doors (Canadian levels)
- selected lighting products (currently not fixtures)
- selected commercial equipment

Canada has also integrated ENERGY STAR with the EnerGuide label for major appliances and room air conditioners to help consumers identify the best-performing products. While the EnerGuide label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. Now that industry-accepted standards of high efficiency have been established, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

Pilot projects were implemented in partnership with seven Canadian gas utilities and a non-government organization to address three major barriers to higher efficiency: awareness, accessibility to high-efficiency products and acceptance.

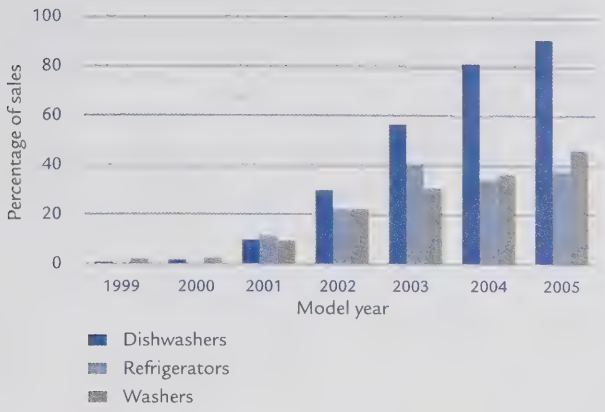
With NRCan's involvement, several utilities doubled the number of incentives and/or loans that they would have disbursed without government participation or under their previous programs. The organizations also coordinated the delivery of coupons from manufacturers to complement the incentives. Canada's participation in this initiative also helped to increase the market penetration of high efficiency gas-fired furnaces and boilers and to include higher efficiency products from markets that supported mid-standard-efficiency products in the past.

ENERGY STAR was also used as the basis for sales tax rebates in British Columbia for heating and cooling equipment, and in Saskatchewan for the purchase of furnaces, boilers and qualifying appliances (refrigerators, dishwashers, clothes washers and freezers). Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher-efficiency products.

Continuous promotion of ENERGY STAR qualified appliances has paid off. Industry statistics for 2005 show an increase in market penetration from almost nil in 2000 to 38 percent for refrigerators and 91 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and the willingness of manufacturers to raise their products to qualifying levels. ENERGY STAR specifications and levels are periodically updated as product saturation is reached to encourage industry to strive for more efficient products and thus maintain the relevance and credibility of the brand.

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005



ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to traffic signals. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and to address barriers to their widespread acceptance.

One example is NRCan's support for the accelerated replacement and promotion of light-emitting diode (LED) exit signs for retrofit applications in Alberta. Exit signs operate around the clock; and for high-rise buildings, with a minimum of four signs per floor at approximately 25 watts (W) for each sign, these products represent a constant electrical draw and, therefore, an energy savings opportunity for building owners.

The project objectives were to

- target apartment building owners
- stimulate demand for LED exit signs
- increase awareness of the benefits of early replacement of standard incandescent exit signs with more efficient LED units that consume 5 W

The project also included recycling the replaced units. The program influenced the conversion of 7311 incandescent exit signs with LED exit signs. This change will save approximately 1.6 gigawatt hours of electricity and 570 tonnes of carbon dioxide annually. For all new installations, the Regulations require that exit signs meet the ENERGY STAR level of 5 W per face.

Canada continues to promote ENERGY STAR guidelines to procurement officials. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions that are associated with the purchase of ENERGY STAR qualified products. Workshops were held across Canada to make governments, institutions and municipal officials aware of the ENERGY STAR criteria and procurement tools. Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products for replacement equipment.

Canada continues to expand the types of products included in its ENERGY STAR agreement. For example, Canada recently included vending machines, commercial refrigeration, compact fluorescent lamps and commercial clothes washers in its correspondence with the U. S. government.

NRCan developed a rating and labelling system for efficient refrigeration applications in ice and curling rinks, under the name CoolSolution.* CoolSolution designates innovative technologies and practices and consists of three main elements:

- heat recovery from the refrigeration system to meet all the building heating requirements (e.g. hot air, hot water) or to export this energy for other purposes

* CoolSolution is an official mark of Her Majesty the Queen in the Right of Canada as represented by the Minister of Natural Resources.

- adaptation to the Canadian climate by taking benefit of the naturally occurring cold temperatures. This is done by varying the temperature of the heat that is released into the environment according to the outdoor temperature.
- reduction of the synthetic refrigerant charges of the refrigeration system, which have a serious adverse impact on climate change. This is done by confining the synthetic refrigerant to the mechanical room and using environmentally friendly fluids to remove and distribute heat.

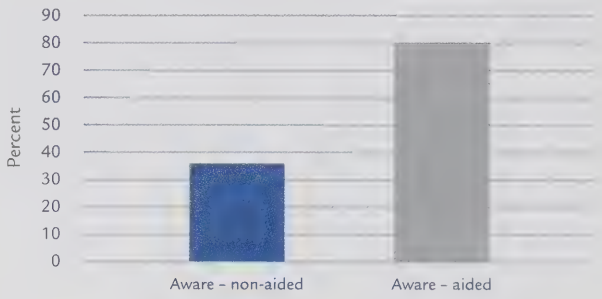
An ice rink application is qualified "CoolSolution" if it has a score higher than 50 percent. An incentive program to encourage the adoption of CoolSolution and reduce the initial payback of the first implementations started in November 2006. Partnerships to accelerate the program have been successful. (See Chapter 4: Buildings.)

Key 2006–2007 Achievements

- Held three workshops with public sector procurement officials.
- Participated in federal-level greening government committees and department-level sustainable development committees to include ENERGY STAR.
- Worked with the Ontario Power Authority and Social Housing Services Corporation on procurement of ENERGY STAR equipment and incentives.
- Provided cost-shared incentives for selected ENERGY STAR qualified heating equipment through various stakeholder organizations (gas utilities, the Ontario Power Authority).
- Established a framework for a strategic lighting initiative.
- Established high performance criteria for decorative lighting for ENERGY STAR in Canada (an international first).
- Maintained 28 CSA energy performance subcommittees, published four CSA standards and completed nine technology and market studies.

FIGURE 2-5

ENERGY STAR Awareness Levels in Canada, 2005



CHAPTER 3

Housing

ENERGY USE AND GREENHOUSE GAS EMISSIONS

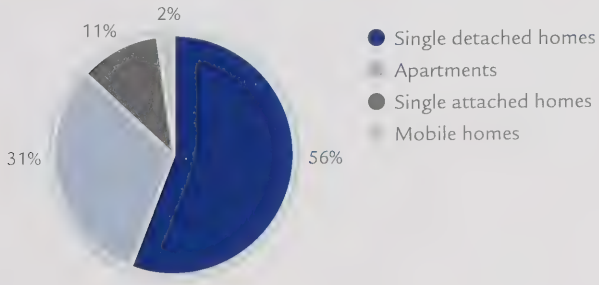
The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water, and for operating appliances, electronic equipment and lights. This sector accounts for 16.5 percent (1402 petajoules [PJ]) of secondary energy use and 14.9 percent (74 megatonnes [Mt]) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses. The next largest number of dwellings is apartments, followed by single attached dwellings and mobile homes (see Figure 3-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating constitute 78.0 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 3-2).

FIGURE 3-1

Canadian Households by Type of Dwelling, 2005



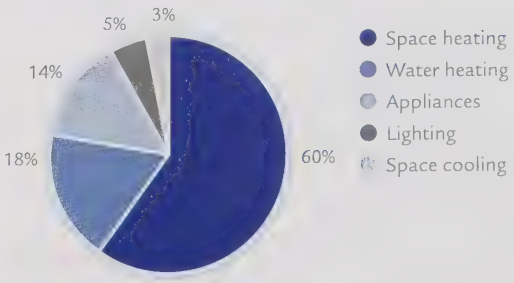
Between 1990 and 2005, residential energy use increased by 9.0 percent, or 116 PJ (from 1286 to 1402 PJ). For the same period, GHG emissions from the residential sector increased by 6.3 percent. GHG intensity changed little because fuel switching toward less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Five main factors influenced residential energy use—activity, weather, structure, service level and energy efficiency:

- activity – The increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 27.5 percent (353 PJ).
- weather – The winter in 2005 was similar to the winter in 1990 but summer temperatures were much warmer and the result was a 0.4 percent (6 PJ) increase in energy use in 2005 compared with 1990.
- structure – The relative share of households by dwelling type (single detached, apartments, etc.) has changed over the period. This change contributed to an increase in energy use of 0.6 percent (7 PJ) in 2005 compared with 1990.
- service level – The increased penetration rate of appliances and increased floor space cooled by space cooling units increased energy use by 5.5 percent (71 PJ).
- energy efficiency – Improvements in energy efficiency decreased energy use by 24.9 percent (321 PJ).

FIGURE 3-2

Residential Energy Use by Purpose, 2005



The change in residential energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency are shown in Figure 3-3. Figure 3-4 shows how energy consumption differs for houses built in different periods, which reflects improvements in building construction.

Growth in residential energy use was driven in large part by growth in activity. This growth in activity, which is, more specifically, growth in total floor space and number of households, was due to the increase in the average size of newly constructed houses, the rising population and the trend toward fewer individuals per household (see Figure 3-5). Such increases were partially offset by significant improvements in energy efficiency. Structural changes also contributed to growth in energy use as more individuals tended to live in single detached homes and the relative share of individuals living in apartments declined. Similarly, service level increased energy demand because in 2005 more Canadians cooled their homes during the summer months and operated more appliances than they did in 1990.

Figure 3-6 shows how average energy consumption of new appliances has improved by comparing 1990 and 2005 models.

NRCan delivers initiatives to increase energy efficiency in the following residential subsectors:

- new houses
- existing houses
- residential equipment (see Chapter 2)

FIGURE 3-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

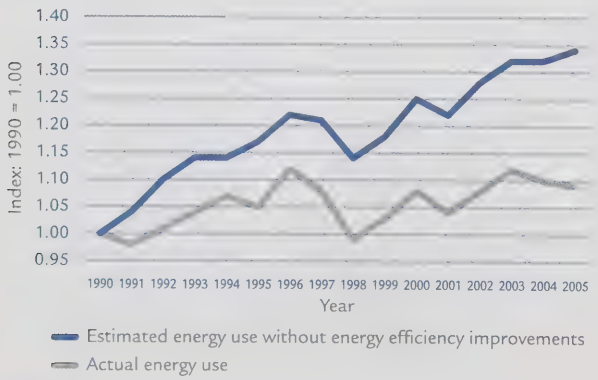
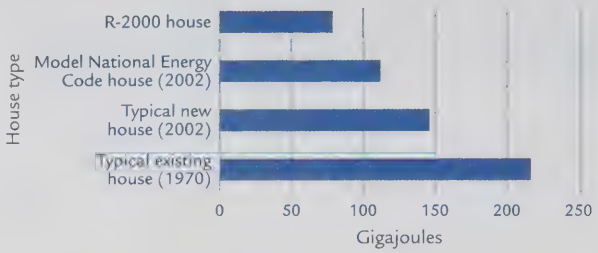


FIGURE 3-4

Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 3-5

Number of Households, Average Floor Space of New Houses and Energy Intensity Indexes, 1990 to 2005

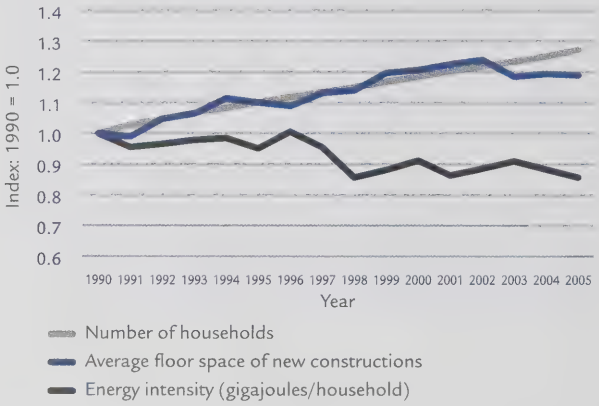
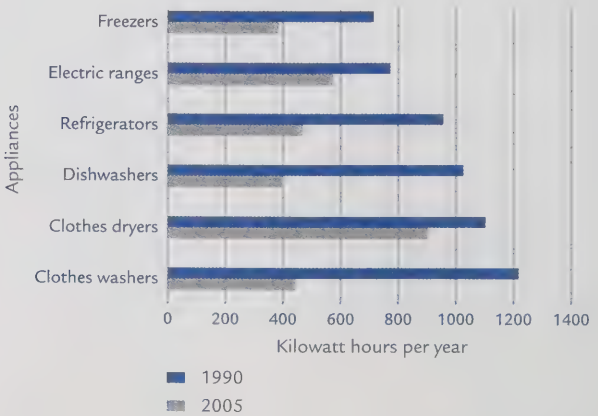


FIGURE 3-6

Average Energy Consumption of New Appliances, 1990 and 2005 Models



NEW HOUSES:
R-2000 Standard and EnerGuide for (New) Houses

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.

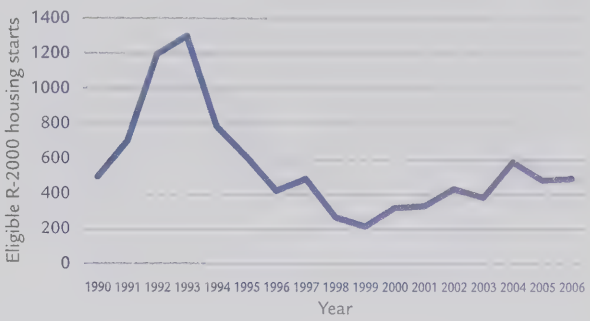
The R-2000 Standard is a voluntary technical performance standard. It encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, houses that are more energy efficient. The EnerGuide for Houses scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders. GHG reductions for fiscal year 2006–2007 were 0.089 Mt.

For more information:
oee.nrcan.gc.ca/r-2000/english

FIGURE 3-7

Number of Eligible R-2000 Housing Starts, 1990 to 2006



Key 2006–2007 Achievements

- Supported 169 workshops nationally and trained 2433 people in energy-efficient construction systems for the new housing sector.
- Supported the Heating, Refrigeration and Air-Conditioning Institute and made available 38 courses about the design and installation of heating, ventilating and air-conditioning (HVAC) systems for 557 individuals.
- Achieved 10 percent penetration in the new housing market in Ontario (responsible for 45 percent of the new housing starts in Canada), largely as a result of efforts with tract builders.
- Collaborated with provinces to incorporate energy efficiency requirements within building codes. British Columbia, New Brunswick, Nova Scotia, Ontario and Quebec announced moves to achieve an energy rating level of 80 points by 2012. Eighty is the minimum rating for an R-2000 house.

EXISTING HOUSES:
EnerGuide for Houses and Retrofit Incentives

Objective: To encourage Canadians to improve the energy efficiency of their homes.

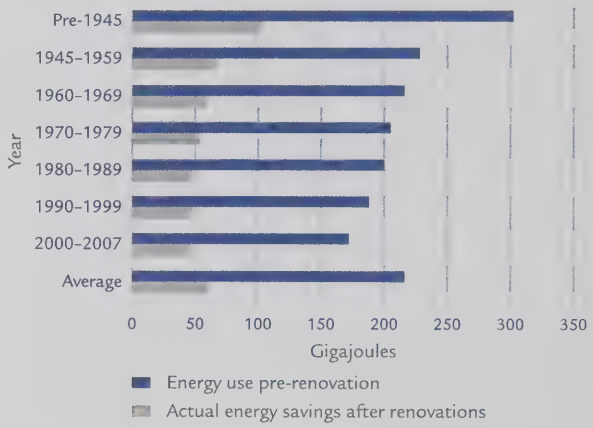
EnerGuide for Houses gave Canadian homeowners personalized advice about how to best improve the energy performance of their houses, especially for renovation and maintenance projects. Under EnerGuide for Houses, a retrofit incentive was officially launched in October 2003. Under this incentive, homeowners qualified for a non-taxable grant representing 10 to 20 percent of their retrofit expenditures. The grant was based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EnerGuide for Houses energy evaluation. The program was terminated in 2006, but received $45 million in funding to be used for wind down activities.

Key 2006–2007 Achievements

- Processed more than 105 000 grants under the retrofit incentive.
- Achieved cumulative GHG reductions of 0.9 Mt as of March 31, 2006.
- Signed six Memorandums of Agreement with provinces and municipalities to ensure a smooth transition to provincial and municipal programs.

FIGURE 3-8

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007



NEW AND EXISTING HOUSES:
Energy Science and Technology in Housing

Objective: To accelerate the development and market adoption of energy-efficient housing technologies in domestic and foreign markets through improved design, performance and cost-effectiveness and to develop practical decision-making tools to help communities and developers choose efficient energy systems and low-polluting waste and water technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) develops and deploys highly specialized solutions to help achieve cost-effective reductions in the energy consumption and GHG emissions of residential housing. CETC experts in energy innovations for the built environment take a leadership role, nationally and internationally, in the research, development, and deployment of leading-edge energy-efficient and renewable energy technologies for new and retrofit housing.

Key focuses of CETC take into consideration the following:

- Design and analysis tools remain a key element for accelerating innovation in both the new housing and retrofit markets. The ability to model emerging technologies to ascertain potential impacts and identify other opportunities is essential. The advancement of the design tools must keep pace with evolving technologies.
- Guidelines for both new and retrofit housing projects remain a high priority to enable voluntary, incentive-driven and regulated improvement to the housing stock.
- Energy demand reduction continues to offer opportunities in housing for improved envelope technologies and more efficient HVAC technologies.
- Improved energy systems, including integrating cogeneration, fuel cell and renewable energy alternatives, are essential to meeting long-term energy use goals.

Key 2006–2007 Achievements

- The success of a zone heating and cooling product named Zone Comfort is a great example of how CETC supports technology innovation in the private sector. Zone Comfort addresses comfort, humidity, energy, and peak energy demand in the summer. Key technical aspects of this new product evolved from the participation of Ecologix Heating Technologies Inc. in the ēKOCOMFORT®* initiative. This product demonstrates how CETC supports technology innovation in the private sector and effectively guides innovative technologies from concept to commercialization and reduces the time to market. In this case, time to market was 18 months. CETC created a complete commercialization team that included market research, a development plan, a sales plan, funding and technology support.
- A research project used a hybrid hydrogen generator and natural gas furnace to evaluate if combustion appliances such as a furnace or hot water tank can burn more cleanly without requiring a retrofit. CETC evaluated the risks and performance characteristics of the combustion appliances. The test fuels were hydrogen and natural gas mixtures whose composition ranged up to 25 percent hydrogen. Results showed that a mixture of natural gas and 10 percent hydrogen is viable. Future integration with wind turbines and excess off-peak power is under consideration.

* ēKOCOMFORT is a registered trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

- Super E™* housing is a technology transfer initiative that has increased market penetration of energy-efficient housing technologies and building practices from Canada into international markets. Through Super E, CETC has helped Canadian companies adapt their products and services to meet increasingly higher international demands for environmentally friendly and energy-efficient housing. The Super E consortium includes 39 Canadian housing exporters who partner with 48 overseas companies. As of March 2007, over 400 houses were completed or under construction in markets such as Japan, the United Kingdom, Ireland, China, Korea and Iceland. The benefits to Canada are estimated at more than $40 million since the beginning of the initiative. Super E has also influenced the energy efficiency standards of housing packages offered by Canadian Super E members to the Canadian marketplace. Super E is delivered by CETC in partnership with the Canadian Forestry Service and the Canada Mortgage and Housing Corporation.
- CETC develops and supports building simulation software for the Canadian housing industry. Using the HOT2000™** software created by CETC, 275 000 houses have been simulated for improved energy efficiency. CETC also develops and validates improved methods for modelling conventional energy systems while integrating more sophisticated technologies such as co-generation and renewable energy systems. Through the International Energy Agency – Energy Conservation in Buildings and Community Systems Annex 42, CETC developed simulation models for residential scale co-generation systems and tested natural gas technologies (e.g. fuel cells, Stirling engines, internal combustion engines) to validate these models.
- A project with CETC and the City of London, Ontario and seven of its local builders was undertaken to provide the builders with a method to systematically evaluate new energy-efficient products, systems and techniques. Some builders sent three or four staff to technology sessions as part of this project and are now starting to use the technologies. As a result of this project, the London Home Builders Association is now sponsoring its own project technology sessions. The City of London is very pleased with the results, and is creating an implementation plan for the subsequent field trial phase.

For more information:
sbc.nrcan.gc.ca

* Super E is a registered trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

** HOT2000 is an official mark of Natural Resources Canada.

CHAPTER 4

Buildings

ENERGY USE AND GREENHOUSE GAS EMISSIONS

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2005, the commercial/institutional sector accounted for 13.6 percent (1153 petajoules [PJ]) of secondary energy use and 13.2 percent (65.3 megatonnes [Mt]) of greenhouse gas (GHG) emissions.

To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 4-1). Offices account for 35 percent of the sector's energy demand. Retail trade, educational services, health care and social assistance, and accommodation and food services account for another 47 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all these major energy-using activity types.

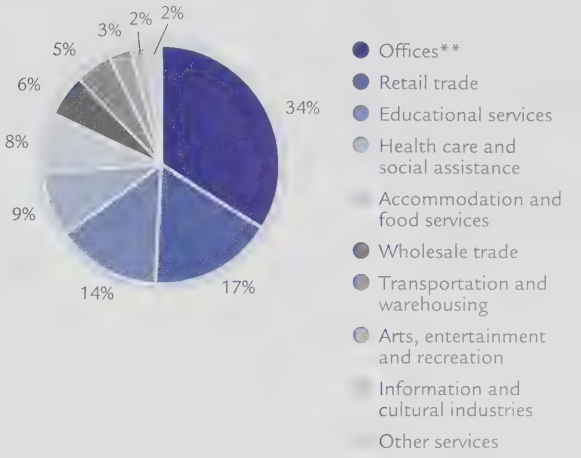
Energy is used for six purposes in commercial/institutional activities. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 4-2). Each of the remaining five uses of energy accounts for between 8 and 14 percent of energy demand in this sector.

Between 1990 and 2005, the commercial/institutional energy use increased by 33 percent, or 286 PJ (from 867 to 1153 PJ).

However, GHG emissions from the sector rose by 36.7 percent in the same period. Emissions increased more quickly than energy use because of the increased use of energy sources with a higher GHG content.

FIGURE 4-1

Commercial/Institutional Energy Use by Activity Type*, 2005

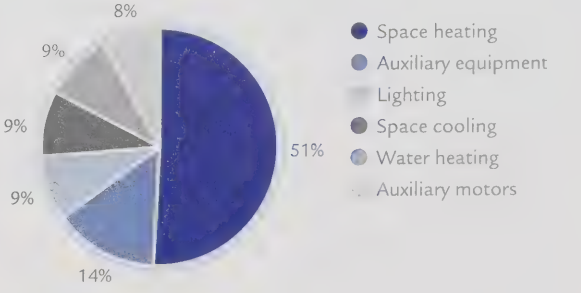


* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 4-2

Commercial/Institutional Energy Use by Purpose*, 2005



*Excludes street lighting

During 1990–2005, a steady increase in activity largely contributed to increased energy use. To a lesser degree, the service level, which refers to the increase of auxiliary equipment and the space cooling penetration rate, and the weather affected energy use. The impact of structural changes (the mix of building types) was marginal. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are:

- activity – A 28.1 percent increase in floor space caused a 247-PJ increase in energy use. This year, the Office of Energy Efficiency (OEE) reviewed the historical floor space database.
- weather – The winter in 2005 was colder than in 1990, but the summer was warmer than in 1990. The net result was a 2.9 percent increase in energy use (25 PJ).
- structure – A shift in activity caused a 0.1 percent decrease in energy use (1 PJ).
- service level – An increase in the service level for end-users caused a 10.6 percent increase in energy use (92 PJ).
- energy efficiency – An 8.7 percent improvement in energy efficiency caused a decrease in energy use of 75 PJ.

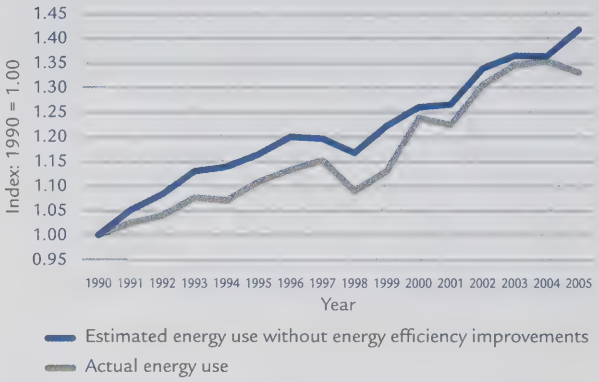
The change in energy use between 1990 and 2005, as well as the estimated energy savings due to energy efficiency, are shown in Figure 4-3.

NRCan delivers initiatives to increase energy efficiency in the following subsectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment (See also Chapter 2.)
- communities

FIGURE 4-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



NEW BUILDINGS:
Commercial Building Incentive Program

Objective: To improve the energy efficiency of new commercial, institutional and multiunit residential buildings.

The Commercial Building Incentive Program (CBIP) provided financial incentives to builders and developers who incorporated energy-efficient features into the design and construction of new commercial, institutional and multiunit residential buildings.

To qualify for the incentive, buildings had to be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code of Canada for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 36 percent more energy efficient than similar buildings constructed to the MNECB.

The program was delivered by the Government of Canada and co-marketed by provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations. CBIP achieved 0.07 Mt of GHG reductions in fiscal year 2006–2007.

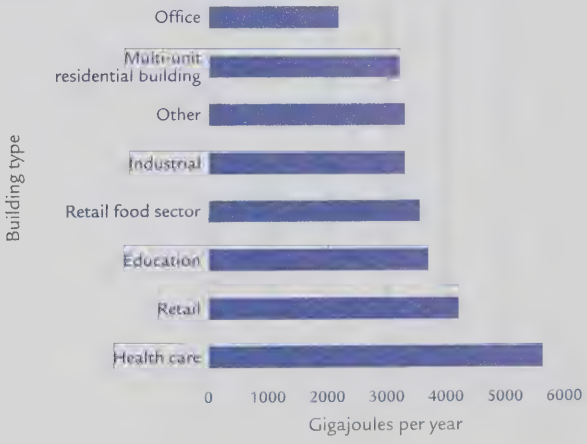
Key 2006–2007 Achievements

- The program validated that more than 250 projects met the CBIP criteria and gave incentives to 229 projects, which represent 5 percent of building starts and 17 percent of construction floor space.
- The registered users of NRCan's building design energy simulation/compliance software increased by more than 1000 to 6500.
- The Canadian Commission on Building and Fire Codes approved a business plan submitted by the NRCan-supported Buildings Energy Codes Collaborative to update the MNECB.

For more information:
oee.nrcan.gc.ca/newbuildings

FIGURE 4-4

Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2006



NEW BUILDINGS:
Industrial Building Incentive Program

Objective: To improve the energy efficiency of new industrial buildings.

The Industrial Building Incentive Program (IBIP), a demonstration program, extended the precepts of CBIP to the industrial sector. IBIP offered an incentive to companies that built new energy-efficient industrial facilities. The incentive offset the additional costs involved in initial attempts to produce energy-efficient designs and achieve building and process integration. The design was assessed against a reference generated from the MNECB. The program resulted in GHG reductions of 0.001 Mt in fiscal year 2006–2007.

Key 2006–2007 Achievements

- Supported two IBIP projects that showed building and process integration. The program supported 28 projects (including these two) since the launch of the program in 2002.
- Produced a case study on refrigerated warehouses.
- Completed five recipient audits of the demonstration projects.

For more information:
oee.nrcan.gc.ca/newbuildings

EXISTING BUILDINGS:
EnerGuide for Existing Buildings or the Existing Buildings Initiative

Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce GHG emissions.

The EnerGuide for Existing Buildings (EEB) program helps commercial organizations and public institutions explore energy efficiency options and strategies. The program provides access to tools and financial assistance to help reduce energy costs and improve competitiveness.

Members join EEB by sending a letter to the Minister of Natural Resources from senior management that states their commitment to energy efficiency. The program has more than 2800 commercial, institutional and multiunit residential organizations as members. GHG reductions in the 2006–2007 fiscal year under EEB were 0.1 Mt.

Key 2006–2007 Achievements

- The EEB program signed 143 contribution agreements for retrofit projects (see Table 4-1) and 61 contribution agreements for planning activities.
- Projects that received financial incentives under EEB are expected to result in averaged energy savings of approximately 20 percent.
- Over 250 organizations registered with the program.

For more information:
oee.nrcan.gc.ca/existingbuildings

TABLE 4-1

EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2006

Fiscal year	Retrofit projects signed	Estimated annual energy cost savings (millions of dollars)	Eligible client investment (millions of dollars)	Federal incentive (millions of dollars)
1998	12	5.67	57.29	2.56
1999	35	16.78	143.17	5.38
2000	4	5.44	9.29	0.62
2001	30	10.57	58.03	3.66
2002	58	19.06	147.53	7.89
2003	66	16.09	140.88	8.37
2004	168	34.88	237.93	16.52
2005	129	23.36	133.62	11.29
2006	143	21.71	156.80	10.40
Total	**645**	**153.56**	**1084.54**	**66.69**

NEW AND EXISTING BUILDINGS:
Refrigeration Action Program for Buildings

Objective: To reduce GHG emissions by reducing energy consumption and synthetic refrigerant use in Canadian supermarkets and ice and curling rinks.

The program activities include information, capacity building, demonstrations, partnerships, and incentives. NRCan delivers the program in partnerships with provincial governments and utilities, associations, manufacturers, and consulting firms.

(See Chapter 2: Equipment, Standards and Labelling.)

Supermarkets provide a window of opportunity for innovative refrigeration systems because new construction and major renovation projects are expected in the coming years. Every three years, approximately 10 percent of the supermarkets undergo major renovation work. Also, approximately 100 large supermarkets are built every year.

There are 2501 ice rinks and 1037 curling rinks in Canada that are used by local communities and contribute to the social well being of many Canadians. Most of these buildings are 25 years old and an estimated 30 to 40 percent of the rinks are operating beyond their projected lifespan.

During the next decade, major renovations of ice rinks will exceed 2000 units, with an additional 1000 units for curling rinks. The potential impacts for these applications have been evaluated at 4.0 Mt carbon dioxide equivalent per year. The energy use savings are in the range of 25 to 50 percent.

Key 2006–2007 Achievements

- RETScreen® Refrigeration software for ice and curling rinks was launched.
- CoolSolution*, an efficient refrigeration application to reduce energy use and contribute to reducing GHG emissions, was implemented to qualify ice and curling rink installations.
- An incentive program was put in place for Canadian ice and curling rinks. Incentives were given for 21 feasibility studies and 25 installations.
- NRCan participated in a Canadian Standards Association committee to update the code for commercial refrigeration, in particular considering the use of carbon dioxide (CO_2).
- NRCan signed an agreement with Loblaw Properties Limited to demonstrate, for the first time in Canada, the use of CO_2 for commercial refrigeration.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/parb_rapb.html

* CoolSolution is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

NEW AND EXISTING BUILDINGS:
Intelligent Buildings

Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.

The program focuses on intelligent building technologies and practices, such as recommissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2006–2007 Achievements

- Continued demonstration projects across Canada aimed at evaluating and improving the Continuous Building Optimization approach and the Diagnostic Agent for Building Operators (DABO) software.
- Delivered advanced retrocommissioning training at CETC-Varennes, in collaboration with Portland Energy Conservation Inc., to enhance the practical knowledge of its demonstration projects partners.
- Improved the DABO software by incorporating performance indices. DABO is the software tool developed at CETC-Varennes to support the process of optimizing building operation and ensure persistence of the energy efficiency measures implemented.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

BUILDINGS AND COMMUNITIES:
Energy Science and Technology in Buildings and Communities

Objectives: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness. To optimize the interactions between buildings, the energy systems involved within them, and their communities. To develop and demonstrate practical decision-making tools and best practices that allow communities to undertake effective energy planning initiatives.

The CANMET Energy Technology Centre (CETC) works in partnership with associations, government and industry. They develop and deploy specialized solutions to achieve cost-effective reductions in the energy consumption and GHG emissions of buildings and communities.

CETC experts in energy innovations for the built environment take a leadership role, nationally and internationally, in the research, development, and deployment of energy-efficient and renewable energy technologies for new and retrofit buildings and communities.

Design and analysis tools remain key elements for accelerating innovation in new construction, retrofit and major renovation projects in large buildings. These tools are essential components of integrated design approaches that allow the implementation of energy efficiency at minimal incremental costs. There is still a lack of uptake for these tools, leading to capacity shortages in the marketplace.

Tools also enable advancement of technologies by allowing a project to simulate ideas rather than run expensive trials at the early high-risk stages and help the integration of emerging technologies

by using advanced design and modelling. Building envelope work in hybrid systems (e.g. building integrated photovoltaics) continues to offer almost untapped (at least by market penetration numbers) opportunities for advancement.

Services such as lighting, daylighting and intelligent building control are key innovation areas, and system recommissioning in existing buildings offers opportunities for energy savings with little physical change. Finally, integration of a diversified energy supply, from fuel cells to renewable energy technologies, represents a significant gap between the current status and the desired status to meet long-term energy goals.

A key barrier that prevents change in standard development practices is the lack of tools and information that relate development style to energy and environmental impact.

Innovation in the following areas can create change:

- tools (computational or others) that consider energy consumption and emissions from the community from a systems perspective
- processes that guide the creation of community strategies for energy efficiency and the reduction of GHGs
- methods that help decision-makers differentiate between urban development alternatives based on their environmental impact on the community
- community energy standards that support policies, codes and technical standards for energy-efficient development practices

Key 2006–2007 Achievements

- The Code Commission agreed to update the MNECB for 2012. CETC founded the Building Energy Code Collaborative with provincial, territorial and NRCan representation. The Collaborative submitted a business plan to the Code Commission for the update.
- A combined heat and emergency power system was installed at Villa Colombo, a long-term care facility in Vaughn, Ontario, to replace the oil-fired emergency power plant. This 335-kilowatt natural gas unit provides both heat and emergency power. A critical component of this project was a revision to the CSA 282 code that previously did not allow the use of natural gas in emergency power systems. This change removes a large barrier to adoption of combined heat and power (CHP) systems and reduces the cost of a CHP system by 20 percent because a separate emergency system is not needed.
- CETC developed a *Community Energy Planning Guide*. The guide helps communities understand and evaluate land use, infrastructure, energy systems, building and site design and waste management decisions in the context of a sustainable energy future. To date, communities have requested 700 guides.
- CETC assessed the feasibility and monitored the progress of the Iqaluit District Energy System project on behalf of the Opportunities Envelope Secretariat. The Iqaluit District Energy System collects waste heat from the diesel-electric power plant in Iqaluit and provides it to a new hospital built adjacent. The system was commissioned in January 2007.
- Construction began for the installation of a 1-megawatt expansion turbine at the letdown station of a gas utility in Toronto, Ontario. This concept replaces the conventional pressure-reducing valve with an expansion turbine, which reduces pressure and, at the same time, uses this pressure reduction to produce electricity by turning a turbine wheel at very high speeds.

For more information:
sbc.nrcan.gc.ca

CHAPTER 5

Industry

ENERGY USE AND GREENHOUSE GAS EMISSIONS

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction. However, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power and to produce heat or to generate steam. Overall, industrial energy demand accounts for 37.9 percent (3209 petajoules [PJ]) of secondary energy use and 33.1 percent (164 megatonnes [Mt]) of greenhouse gas (GHG) emissions (including electricity-related emissions).

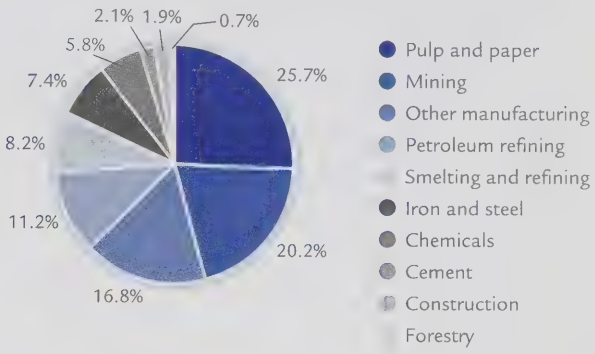
In the industrial sector, energy is consumed primarily in pulp and paper production, mining, petroleum refining, and in the smelting and refining industries. Pulp and paper production alone accounted for approximately 25.7 percent of total industrial energy demand in 2005 (see Figure 5-1).

In most industries, energy purchases account for only a small portion of total expenditures. However, for some relatively energy-intensive industries—cement, aluminum, pulp and paper, iron and steel, and chemicals—this share is higher than 12 percent (see Figure 5-2). For cement, in particular, the share is as high as 37.1 percent.

Actual industrial energy use increased by 17.9 percent (488 PJ) between 1990 and 2005. This increase was caused by a 43.9 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of the increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change (the shift to less energy-intensive industries such as electrical and electronics).

FIGURE 5-1

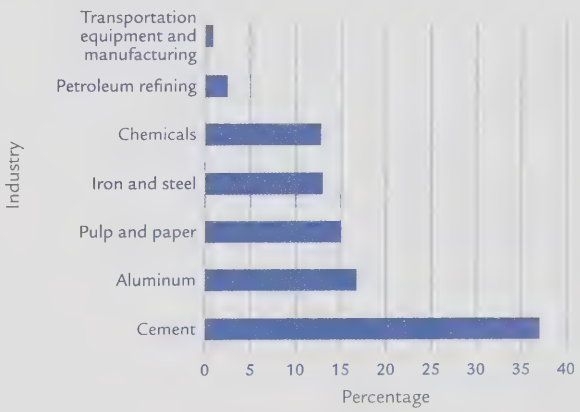
Industrial Energy Use by Subsector – Including Electricity-Related Emissions,* 2005



* Note: The above subsectors reflect the current definitions in the *Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 5-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005



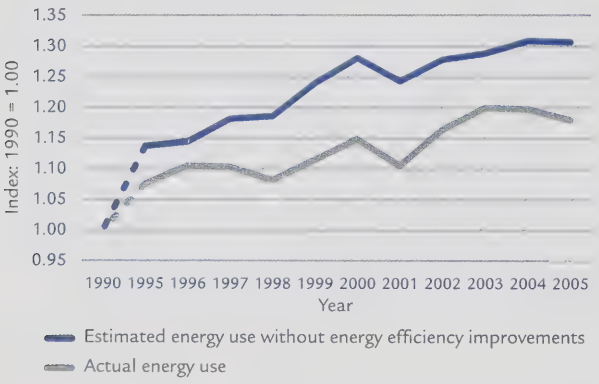
Three main factors influenced energy use:

- activity – Increases in the physical units of production, gross output and GDP contributed to a 43.9 percent increase in industrial activity resulting in a 1166-PJ increase in energy use.
- structure – The change in the mix of activity toward less energy-intensive industries caused a 331-PJ decrease in energy use.
- energy efficiency – Due to a 12.8 percent improvement in energy efficiency, the industrial sector avoided 347 PJ of energy use between 1990 and 2005.

The change in energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency are shown in Figure 5-3.

FIGURE 5-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



Between 1990 and 2005, industrial GHG emissions, including electricity-related emissions, increased by 15.5 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 8.0 percent. Most of this increase in direct GHG emissions occurred in the upstream oil and gas industry, because the mining (excluding upstream), manufacturing and construction industries realized an 8.7 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment (see Chapter 2)
- buildings (see Chapter 4)

INDUSTRIAL PROCESSES AND TECHNOLOGIES:
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation)

Objective: To help Canadian industry use energy efficiency investments to improve productivity and competitiveness and to contribute to Canada's clean air and climate change goals.

The Canadian Industry Program for Energy Conservation (CIPEC) is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors, including the mining, manufacturing, forestry, construction, upstream oil and gas, and electricity generation sectors.

CIPEC's network comprises 28 sector leadership networks (including four regional) that share information and best practices; more than 1000 industrial companies that have made a written voluntary commitment to become more energy efficient and support Canada's climate change initiatives; and partnerships with 52 industry associations that disseminate information and advice on energy efficiency to their members.

CIPEC's multifaceted approach focuses on introducing technological innovations, bringing about behavioural change, and shifting organizational culture to generate a sustainable market transformation. Tools and services offered through CIPEC included energy fora and conferences; communications products including Web sites and newsletters, technical guidebooks, energy benchmarking and best practices studies; Dollars to $ense energy management workshops; cost-shared energy audits and Process Integration (PI) studies; and provision of technical information relating to the eligibility of renewable energy and/or energy efficiency systems for accelerated capital cost allowances under Class 43.1 and Class 43.2 of the *Income Tax Act*. CIPEC achieved GHG reductions of 0.36 Mt in fiscal year 2006–2007.

Key 2006–2007 Achievements

- Conducted energy audits at 137 industrial facilities.
- Trained 1303 industrial energy managers in Dollars to $ense workshops.
- Sent the *Heads Up CIPEC* newsletter to 1500 new industrial clients.

FIGURE 5-4

CIPEC Energy Intensity Index, 1990 to 2005

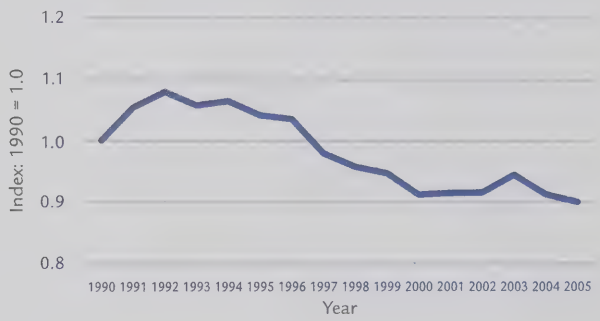


FIGURE 5-5

Estimated CIPEC Energy Savings, 2001 to 2006

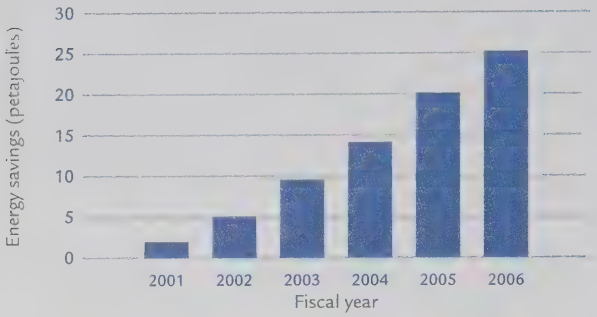
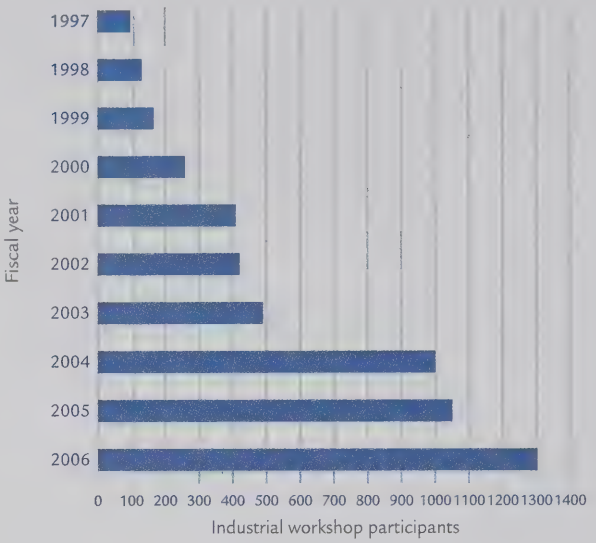


FIGURE 5-6

Industrial Dollars to $ense Participants, 1997 to 2006



INDUSTRIAL PROCESSES AND TECHNOLOGIES: Industrial System Optimization Program

Objective: To support the development and adoption of innovative energy-efficient design practices in Canadian industry to improve energy efficiency and productivity while reducing GHG emissions and other environmental impacts.

The Industrial System Optimization Program focuses on techniques to analyse plant-wide industrial processes, such as PI and advanced process control systems. The Program analyses these processes to identify and correct inefficiencies in plant operation and design, while also considering energy, economy and environmental factors.

The Program tries to meet its objective by conducting leveraged research and development (R&D) through national and international cooperation. Furthermore, the Program disseminates technical information to encourage adoption of these techniques and practices in targeted energy-intensive sectors of Canadian industry. Those sectors include pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, food and drink, and solid wood.

Key 2006–2007 Achievements

- Successfully completed a pilot PI program to promote and implement sound PI practices in 31 plants in both regulated and non-regulated sectors. NRCan offers support to help industrial companies conduct PI studies to identify opportunities for increasing energy efficiency and improving production processes. By using energy more efficiently, industry can become more competitive and help reduce GHGs and air pollution. It is estimated that annual energy-cost savings of approximately $1 billion and economic spin-offs of approximately $6 billion are achievable over a 5-year period. The PI program also represents a major opportunity to change the way energy analysis is conducted in the industry, thereby improving productivity and competitiveness of this sector.

- Developed a systematic approach to assess potential upgrading of distillation systems in the chemical industry. A clear methodology was developed, Thermodynamically Guided Modelling, for top-level analysis of the energy, purity and productivity tradeoffs in separation processes and for structural optimization of retrofit separation installations. For example, the conceptual retrofit design of a C_2 splitter of the NOVA Chemical ethylene site was completed. The potential energy savings in the heat supply can reach up to 47 percent. The savings in the heat supply correspond to electrical power savings of 5.6 megawatts in the refrigeration system that serves the C_2 splitter. These results will be key assets for future studies on petrochemicals.
- Developed a multi-objective optimization methodology for industrial production systems. This methodology simultaneously integrates the adaptability of an algorithm, advanced constraint handling, system decomposition, a combined local optimality search and global optimality determination. The algorithm gives a choice of solutions that represents the best trade between the targeted objective functions.

For more information:
cetc-varennes.nrcan.gc.ca/en/indus.html

INDUSTRIAL PROCESSES AND TECHNOLOGIES: Industry Energy Research and Development Program

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

The Industry Energy Research and Development (IERD) program gives financial support for commercially confidential applied R&D activities. If the project is a commercial success, the clients must repay the funds. Program clients from all industrial sectors range from small and medium-sized companies to multinational corporations.

Key 2006–2007 Achievements

- DDI-Heat Exchangers Inc. of Dollard-des-Ormeaux, Quebec successfully demonstrated that its Cube™ heat exchanger technology can recover heat from liquids (sludge) containing a high percentage (65 percent) of suspended solids in an application where conventional heat exchanger designs have failed. This demonstration helped DDI sell its heat exchanger technology to a bio-solids processing plant in the United States (U.S.). Considering the untapped market for heat recovery from sewage sludge and other high viscosity liquids in industry, it is projected energy savings will be 11 PJ and projected carbon dioxide (CO_2) reduction from the heat exchanger technology in Canada will be 0.545 Mt over the next 10 years.
- The Puratone Corporation of Niverville, Manitoba, developed an energy management system for hog producers. This award-winning system is called "BarnMax." The technology is expected to help hog producers reduce energy consumption by an average of 86 megajoules for each pig produced. Energy savings from BarnMax technology in Canada over the next 10 years is projected to be 15 PJ. Over the same period, the technology is expected to reduce CO_2 emissions by 0.726 Mt.

- The IERD program supported General Comminution Inc. (GCI) of Toronto, Ontario in a full-scale field trial. The trial proved the technical feasibility of the GCI Szego mill to reactivate spent sorbent for a fluidized bed combustion boiler. Using reactivated limestone will reduce CO_2 emissions from limestone calcination and will also reduce the landfill requirements for solid wastes. Successful implementation will result in reduced landfill requirements for spent sorbent and a reduction in GHG emissions by 14 850 t annually initially in Canada, growing to 162 000 t in North America with the potential to reach 1 305 000 t globally by 2011. Total energy savings in Canada from implementation of the development is 222 750 gigajoules (GJ) annually.
- Financial support was provided in conjunction with the BC Hydro Power Smart Progam for a field trial of a newly developed pulp screen rotor by the University of British Columbia. Other supporters of the project were Canadian Forest Products and Advanced Fiber Technologies. The new rotor used 52 percent less electrical energy than the conventional equipment it replaced. The potential energy savings if all 300 pulp mills in British Columbia were converted are 153 200 megawatt hours of electricity annually.
- A project with Hamilton Steel G.P. Inc. was completed with results of a reduction of 104 500 t of CO_2 annually and an annual energy reduction of 260 000 GJ for their No. 5 Blast Furnace project in Hamilton, Ontario. The project was one of several initiated almost eight years ago by Union Gas Limited of Chatham, Ontario with IERD and Technology Early Action Measures. The objective was to convert key heavy industry production processes from high-carbon fuel (oil or coal) to lower-carbon natural gas using advanced, innovative technologies. The funding partners were Hamilton Steel, NRCan, Union Gas Limited and Air Liquide Canada Inc. Based on an advanced computational fluid dynamic modelling by the CANMET Energy Technology Centre in Ottawa, Ontario, the approach taken was to optimize the co-injection of pulverized coal and natural gas in the blast furnace. This process enabled the displacement of a greater percentage of the coke requirement and resulted in reductions in overall CO_2 emissions from the site as well as other benefits such as cost reduction and productivity improvement.
- With IERD support, Agile Systems Inc. successfully completed an R&D program for integrated electronic motor controls. The potential energy savings by 2012 are 2013 terajoules and GHG emission reductions of 109 105 t.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Publications/ierdpublications/factsheet_industry_energy_r&d_e.htm

INDUSTRIAL PROCESSES AND TECHNOLOGIES:
Clean Electric Power Generation

Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency and the reduction, and ultimately elimination, of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.

Research focuses on improving the performance of and reducing emissions from existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or nearly complete capture and elimination of CO_2 and other emissions. Issues covered by other research projects include the transport and storage of CO_2.

NRCan's work also includes changing the interaction of the combustion system within the process through advanced tools and technologies to assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions and emissions of other air pollutants, while enhancing competitiveness and profitability.

Key 2006–2007 Achievements

- Completed a technology feasibility study that identifies the ThermoEnergy Integrated Power System Process, a new generation power cycle, as having technical and economic advantages over existing clean coal technologies currently identified in both Canada and the U.S.
- Developed a combustion methodology to burn emulsified bitumen and water mixtures cleanly in conventional boilers in place of more expensive fuels. This technology will be used to support the economic viability of Canadian industries in the resource recovery sectors and to ensure a reliable and inexpensive supply of electricity from Canadian utilities.
- Assembled an International Flaring Consortium comprised of seven private sector and special interest organization members to establish best practices for industrial flares to minimize climate change effects and the health impacts of all industrial flares and to improve air quality.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/clean_electric_power_generation_e.htm

INDUSTRIAL PROCESSES AND TECHNOLOGIES:
Processing and Environmental Catalysis Program

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits.

The program's facilities, including semi-pilot-scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, engine manufacturers, waste oil recyclers and renderers, and specialty ceramic manufacturers.

Key 2006–2007 Achievements

- Developed technology for desulphurizing diesel fuel that is produced by thermally cracking waste lubricating oil. A bench-scale continuous processing unit was commissioned for testing the CANDES process. The project has support from the waste oil recycling industry.
- Determined the preferred operating conditions to transform bitumen residue from oil sands upgrading to an additive suitable for making high quality concrete.
- Developed a direct ammonia fuel cell with unique catalytic surfaces for efficient combined heat and power applications. Bench-scale fuel cell development is being undertaken by three federal laboratories. A field trial using ammonia and the catalytic fuel cell surface in a conventional 5-kilowatt fuel cell control system is being arranged in partnership with a fuel cell and ammonia company.

INDUSTRIAL PROCESSES AND TECHNOLOGIES:
Mine Ventilation

Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management and less air-volume-demanding technology.

Ventilation is required in underground mines to maintain a safe working environment. It is used to dilute and remove harmful pollutants (dusts and gases) and to provide suitable working climates. However, providing adequate ventilation can account for 40 percent of the energy consumed during mineral extraction in underground mines. Ventilation systems naturally include some over-supply capacities in order to accommodate all potentially available production locations. This over-supply is highly dependent on the individual mine, the mineral deposit and the mining method employed.

Metal mines that were traditionally designed to operate at maximum delivery – i.e. peak demand across all potential production locations 24 hours a day, 7 days a week – are now starting to adjust ventilation systems to match actual production needs. Energy savings can be significant and include potential reductions in the use of the auxiliary and main ventilation infrastructure, as well as savings in the energy used in air cooling or heating processes.

Optimizing energy use and reducing GHG emissions and costs is not a straightforward proposition because it depends on the specific consumption profile (i.e. electricity versus heating fuels and primary versus secondary delivery systems), design criteria and geographic location of each mine and therefore requires evaluation on a case-by-case basis.

Key 2006–2007 Achievements

- To assess potential cost savings, energy requirements and GHG reduction strategies, CANMET Mining and Mineral Sciences Laboratories worked on a process-based modelling approach for determining ventilation needs. Historical production data from a large northern Ontario mine was used to analyze diesel equipment deployment to estimate the energy savings that could have resulted from adjustments in the ventilation regimes, based on activity. Results show that depending on the level of automated control, energy cost savings of the order of 50 percent or higher could have been realized at that mine.
- The concept of ventilation on demand continues to be investigated through collaborative work with Hydro-Québec and the Quebec mining industry. The impact of automation of ventilation systems will be investigated in representative mine operations and will be extrapolated to all Quebec mines.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

INDUSTRIAL PROCESSES AND TECHNOLOGIES: Enhanced Recycling for Minerals and Metals

Objective: To reduce GHG emissions from Canada's minerals and metals sector by enhancing mineral and metal recycling processes and practices.

The Enhanced Recycling Program for Minerals and Metals aims to increase Canada's potential to recycle mineral and metal materials by developing new approaches and improving on existing recycling infrastructure, practices and policies. In August 2006, the Program received $505,000 for the implementation of selected projects that held high potential for GHG emission reductions.

The Enhanced Recycling Advisory Committee expanded to include a broader range of experts. The 2006–2007 implementation plan identified three main initiatives: scrap metal from municipal sources; end-of-life roofing materials; and federal government waste electronic and electrical equipment.

Key 2006–2007 Achievements

- An estimated 40 000 t (52 000 t of CO_2 equivalent [CO_2e]) of municipal stockpiled scrap metal was identified for recycling in northern communities of British Columbia, Alberta, Saskatchewan, Manitoba and the territories. The Ottawa Valley Waste Recovery Centre in the Township of Laurentian Valley, Ontario, expanded its residential curbside collection of metal recyclables, resulting in a tripling of revenues from $50/t to $195/t. A Nova Scotia pilot project proposed to add empty paint and aerosol cans to municipal curbside collection programs, resulting in savings of 5460 t of CO_2e annually.
- A workshop with experts from across Canada and the U.S. took place in Toronto, in February 2007, to evaluate options for environmentally sound recycling of roofing materials. It was estimated that 1.25 million t of asphalt-based roofing materials are discarded annually in Canada. If 5 percent of this discarded material is substituted for virgin asphalt, this would produce an annual savings of 90 000 t of CO_2e. Two key applications for recycled asphalt are for road surfaces and energy recovery.
- NRCan, in consultation with key stakeholders, is developing a Federal Government Waste Electronic and Electrical Equipment Strategy that will ensure environmentally sound recovery and recycling of end-of-life information technology equipment arising from government use (65 000 computers per year, or 1000 t of CO_2e).

For more information:
recycle.nrcan.gc.ca

INDUSTRIAL PROCESSES AND TECHNOLOGIES:
Supplementary Cementing Materials Program

Objective: To reduce annual GHG emissions by promoting increased use of supplementary cementing materials (SCMs) in concrete as partial replacement of cement.

The Supplementary Cementing Materials (SCM) Program has the objective of increasing awareness of the benefits of SCMs, both in terms of GHG reduction potential and the performance of concrete. In August 2006, the Program received $235,000 specifically to conduct the following two activities:

- disseminating of information dealing with the use of SCMs in concrete and holding consultative meetings, in order to increase acceptance from stakeholders and to better understand stakeholders' positions and concerns
- assessing improvement in SCM use by conducting a qualitative assessment survey and evaluating the change in SCM use during the last three to five years

Key 2006–2007 Achievements

- Disseminated SCM information through the development and distribution of a brief, yet informative, *SCM Basics* document and a series of consultative meetings with key industry and government stakeholders. Feedback was obtained at 18 consultative meetings, held in 9 cities, with approximately 80 people in attendance.
- Conducted an online survey for a qualitative assessment. The survey response (173 completed) was statistically significant and satisfactory, considering the small number of people who could respond to the specialized topic.
- Interviewed stakeholders across Canada. The information collected confirmed the increased use of SCMs during the last three to five years:
  - Manitoba Infrastructure and Transportation is increasing the amount of fly ash in its specification from 0 percent to 15 percent.
  - The City of Winnipeg, Manitoba, is experimenting with a change to 25 percent fly ash in city roads and sidewalks.
  - Inland Cement is introducing a sulphate-resistant blended cement incorporating approximately 30 percent fly ash.
  - The average content of fly ash in concrete in Nova Scotia in 2002 was from 17 percent to 19 percent, as opposed to 6 percent in the rest of Atlantic Canada.

For more information:
scm.gc.ca

CHAPTER 6

Transportation

ENERGY USE AND GREENHOUSE GAS EMISSIONS

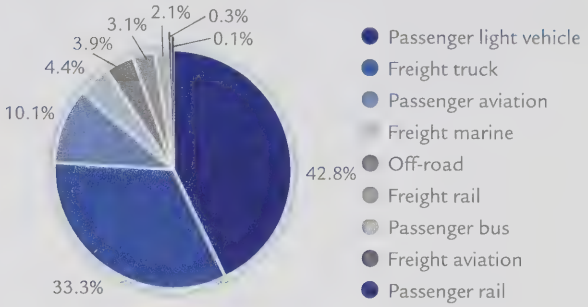
The transportation sector consists of three subsectors: passenger, freight and off-road. Passenger and freight transportation accounted for 55.0 percent and 41.1 percent, respectively, of transportation energy use, and off-road represented only 3.9 percent in 2005 (see Figure 6-1). Due to limitations in the available data and the small percentage it accounts for, the off-road subsector is not analysed in further detail.

The passenger subsector has three modes: road, rail and air. The freight subsector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine modes. In these two subsectors, road transport uses the most energy, accounting for 78.1 percent of total transportation energy use in 2005. Of this amount, 57.4 percent was passenger energy use and 42.6 percent was freight energy use.

All transportation energy-use programs in NRCan focus on the energy used in road transportation. Total transportation energy use increased by 33.2 percent (624 petajoules [PJ]) between 1990 and 2005 (see Figure 6-2). Passenger transportation energy use increased by 15.9 percent (189 PJ), while freight transportation energy use increased by 61.5 percent (391 PJ).

FIGURE 6-1

Transportation Energy Use by Mode, 2005



Three main factors influenced energy use:

- activity – Increases in population and economic activity caused increased transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation). The change in activity increased transportation energy use by 40.0 percent (750 PJ). The freight and passenger segments contributed to this increase by 52.4 percent and 47.6 percent, respectively.
- structure – Shifts between modes of transport within both the freight and passenger segments caused an increase of 9.9 percent in transportation energy use (187 PJ). The effects of mode shifting were more pronounced in the freight segment because freight truck activity is growing faster than rail and marine activity.
- energy efficiency – Improvements in energy efficiency decreased energy use by 18.8 percent (352 PJ).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 49.9 percent (937 PJ). However, actual energy use increased by only 33.2 percent. This change in energy use between 1990 and 2005, as well as the estimated energy savings due to energy efficiency, are shown in Figure 6-2.

The transportation sector accounts for 29.5 percent (2502 PJ) of secondary energy use and 35.9 percent (178 megatonnes [Mt]) of greenhouse gas (GHG) emissions. From 1990 to 2005, transportation energy use increased by 33.2 percent, and GHG emissions increased by 31.8 percent. The change in GHG intensity of transportation energy use was negligible.

Figure 6-3 shows how the market share of new light trucks increased in the 1990s, reflecting the increase in popularity of minivans and sport-utility vehicles. Recently however, this trend seems to have stabilized with the share of light trucks remaining steady over the past few years. This higher share of heavier and more powerful passenger vehicles has had a significant effect on the increase in passenger energy use.

FIGURE 6-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

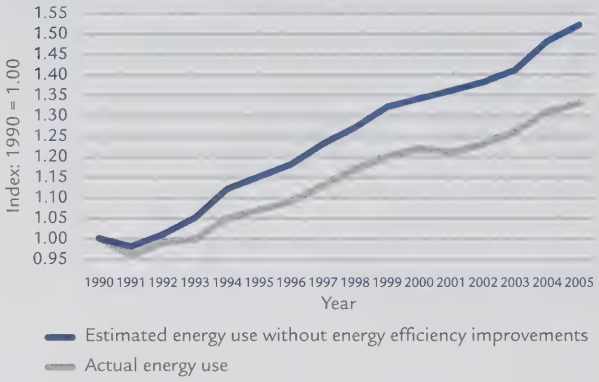


FIGURE 6-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005

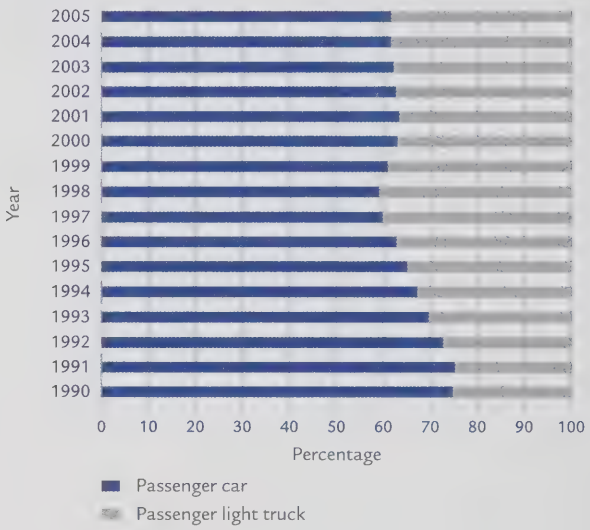


FIGURE 6-4

Average Activity per Truck, 1990 to 2005

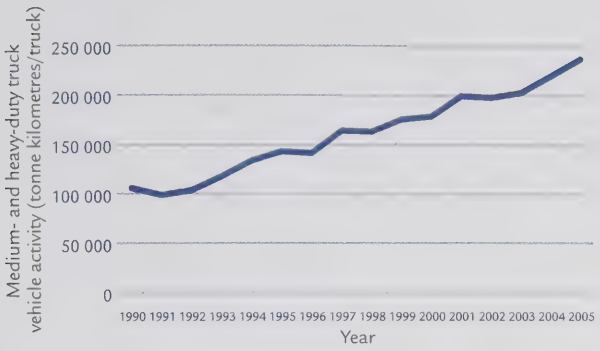
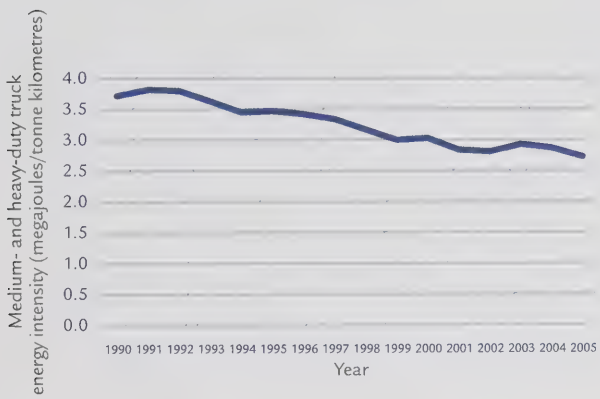


FIGURE 6-5

Trucking Energy Intensity, 1990 to 2005



Figures 6-4 and 6-5 illustrate an improvement in trucking energy intensity despite an increase in average activity from 1990 to 2005. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have improved fuel efficiency in medium- and heavy-duty trucks.

NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

VEHICLES:
Marketing of Efficient Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to purchase energy-efficient vehicles and develop energy-efficient vehicle use and maintenance practices.

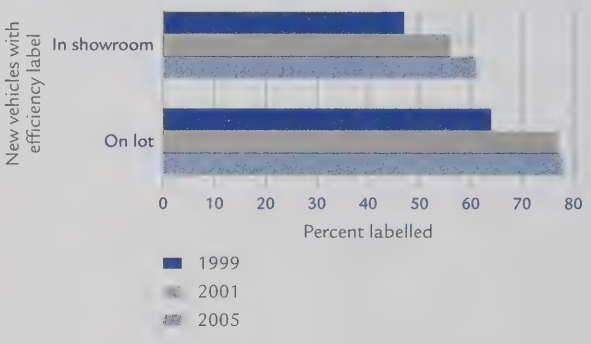
The Marketing of Efficient Vehicles program focuses on education and awareness campaigns that aim to improve fuel conservation behaviour with relation to vehicle selection, maintenance and use. Other objectives are to provide a coordinated approach to vehicle selection and use issues through the provision of information, tools and services to provinces, municipalities and community-level organizations. The program achieved GHG reductions of 0.01 Mt in fiscal year 2006–2007.

Key 2006–2007 Achievements

- Continued a carbon dioxide (CO_2) rating system introduced in 2004. Since its inception, CO_2 information has been distributed to over 1 million Canadians through on-line Web tools and the distribution of the annual fuel consumption guide. A vehicle ranking system is currently under development and in discussion with the vehicle manufacturers.
- Surveys confirmed that
  - 60 percent of drivers believe that changing their driving habits and improving vehicle maintenance will result in reduced fuel costs
  - 71 percent of Canadians considered fuel economy to be an important consideration in their next vehicle purchase
  - 50 percent of Canadians would consider the vehicle's impact on the environment in their next vehicle purchase decision
- One hundred and thirty thousand of the four hundred thousand new drivers taking driver education annually receive the Auto$mart Driver Education program.
- Thirty-three percent of driver instructors in Canada received driver training kits and/or training (the target is to ensure 50 percent of driver instructors are so educated).

FIGURE 6-6

Vehicle Fuel Efficiency Labelling



VEHICLES:
Motor Vehicle Fuel Efficiency Initiative

Objective: To improve the fuel efficiency and reduce the GHG emissions of new light-duty vehicles sold in Canada.

The goal of the Motor Vehicle Fuel Efficiency Initiative is to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan led negotiations with the automotive industry to a successful conclusion, reaching an agreement to reduce GHG emissions from this sector. The auto industry committed to a voluntary reduction in GHG emissions of 5.3 Mt annually from light-duty vehicle use by 2010. This 5.3-Mt target goes beyond fuel consumption reductions by incorporating reductions in all GHG emissions associated with vehicle use.

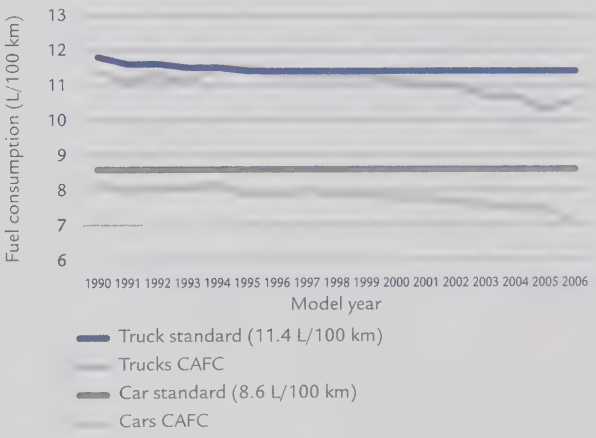
Key 2006–2007 Achievements

- The first progress report for the Motor Vehicle Fuel Efficiency Initiative was released in June 2006. It includes details about the Memorandum of Understanding (MOU), its approach and benefits, as well as the 5.3-Mt reduction goals. The report also outlined the mandate and terms of reference for the joint government-industry committee, which serves as the accountability mechanism to track progress and report on the MOU.
- Idle-free campaigns were conducted in communities that represent 32 percent of the Canadian population. Approximately 100 communities launched a campaign, and 90 percent will continue with their campaign in the 2007–2008 fiscal year. Several communities are implementing idling by-laws; 25 communities have already done so and 25 more are in the planning stages.
- Be Tire Smart campaigns were conducted with approximately 6 million Canadians. Surveys show that the number of people who properly inflate their tires by measuring the tire pressure at least once a month increased by 9 percent between 2003 and 2005. It is estimated that 50 percent of these people improved their tire inflation; this rate of change is expected to stay constant.
- While there was a modest increase of 2 percent in new light-duty vehicle sales in Canada in 2006, the sale of fuel-efficient subcompact vehicles increased by 19.8 percent.

For more information:
oee.nrcan.gc.ca/transportation/fuels/motorvehicles.cfm

FIGURE 6-7

Company Average Fuel Consumption (CAFC) versus Canadian Voluntary Standards, 1990 to 2006*



*2002–2006 data are estimates.

VEHICLES:
Commercial Transportation Energy Efficiency and Fuels Initiative

Objective: To reduce the growth of GHGs from Canada's on-road commercial transportation fleets (passenger and commercial) through increased awareness and uptake of new technologies in energy efficiency, low GHG emissions technologies and alternative fuels.

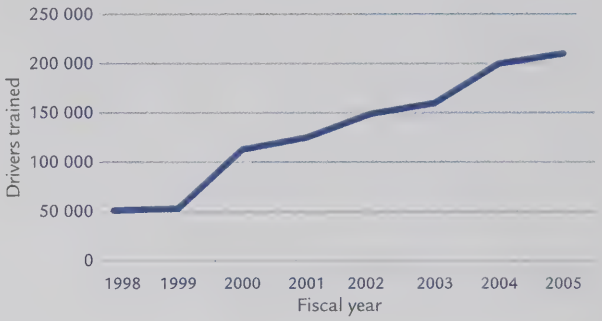
Program delivery focuses on training initiatives such as SmartDriver and education activities to improve fuel conservation and increase awareness about the benefits of efficiency technologies. The Commercial Transportation Energy Efficiency and Fuels Initiative conducts studies and reports, and develops demonstration and technology transfer projects. GHG reductions for fiscal year 2006–2007 were 0.045 Mt.

Key 2006–2007 Achievements

- The demonstration of 3 "Star Trucks" affected the specification improvements of 66 trucks. The improvements are equal to removing 2000 t of GHG emissions from each truck annually.
- Long vehicle configuration was demonstrated along the Québec City–Windsor corridor.
- A Liquefied Natural Gas/Heavy-duty Pilot Ignition demonstration was completed.

FIGURE 6-8

Drivers Trained, 1998 to 2005*



* Estimates are based on NRCan internal data.

VEHICLES:
Freight Efficiency and Technology Initiative

Objective: To reduce the growth of GHG emissions in the on-road freight transportation sector.

The Freight Efficiency and Technology Initiative aims to reduce the growth of GHGs through

- increased participation of the commercial transportation industry in voluntary climate change initiatives
- increased operating efficiency and environmental awareness among commercial transportation carriers and shippers
- increased adoption of existing and innovative environmental technologies and efficient best practices within the freight transportation sector

GHG emissions reductions for fiscal year 2006–2007 were 0.101 Mt.

Key 2006–2007 Achievements

- Conducted four Fuel Management 101 workshops with 55 participants. Thirty percent of participants implemented action plans that led to GHG reductions.
- Initiated an E-learning strategy to facilitate shippers' requirement for environmental carriers.
- Conducted the fifth annual Truck Stop Quiet Zone campaign. Seventy truck stops participated.

TRANSPORTATION RESEARCH AND DEVELOPMENT:
Canadian Lightweight Materials Research Initiative

Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.

The Canadian Lightweight Materials Research Initiative (CLiMRI) is a research network comprising 29 companies, 8 universities and 7 government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight, high-strength materials with transportation applications for the purpose of reducing GHG emissions where vehicle weight reduction results in improving vehicle efficiency and enhancing the competitiveness of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2006–2007 Achievements

- Magnesium alloys are increasingly considered for automotive applications due to the potential for weight reduction, resultant fuel economy improvement and emissions reduction. Magnesium trials were completed to identify the effect of alloying additions, coatings, and sand systems on the fluidity of magnesium. The results indicated that it is possible to cast thin-walled sections for use in future automotive applications. Additionally, coatings were developed for sand casting processes to reduce cover gases used in this process and resulted in high-integrity castings. These achievements show significant potential for increasing the use of magnesium in the automotive industry.
- The demand for lightweight vehicles requires new advanced, high strength steel. The challenge for the steel industry is to develop ultra-high strength steels that have better ductility, to allow the formation of complex shapes. The properties of TRIP and DP steels, in particular, were developed incrementally. New ultra-high strength steels with ductility improvement through the Twinning Induced Plasticity effect show weight reduction and impact resistance. This is a major focus of the CANMET Materials Technology Laboratory (CANMET-MTL) research.
- Titanium components for automotive applications offer high strength, low density and resistance to corrosion. Conventional processing of titanium is expensive, whereas powder injection moulding (PIM) development at CANMET-MTL eliminates most secondary machining processes, is adaptable to high production rates and could reduce production costs by up to 50 percent. CANMET-MTL is evaluating the use of titanium powder in the PIM process.

For more information:
climri.nrcan.gc.ca/default_e.htm

TRANSPORTATION RESEARCH AND DEVELOPMENT:
Fuel Cell-Powered Mining Vehicles

Objective: To develop the technology to replace diesel power with hydrogen fuel cell power in underground mining vehicles.

NRCan has a coleadership role in the North American Consortium for Fuel Cell-Powered Mining Vehicles. Hydrogen fuel-cell power systems are more efficient in delivering power than conventional diesel equipment.

Retrofitting diesel-powered vehicles with hydrogen fuel cells should improve vehicle productivity, operating costs and the work environment for underground miners. Using fuel cells will eliminate toxic underground diesel emissions and reduce heat and noise. Fuel cells have the potential to reduce CO_2 or GHG emissions by up to 1 Mt annually (26 percent of the total CO_2 equivalent emitted by mining extraction) and decrease operating costs by lowering mine ventilation needs.

Key 2006–2007 Achievements

- The first International Symposium on Fuel Cells Applied to Mining was held in Montréal, Quebec. Bringing together mining companies, mining equipment manufacturers, hydrogen and technology suppliers as well as regulatory agencies, the symposium fostered the transfer of technology, highlighting Canada's lead in introducing fuel cells into the mining industry. The European Commission's Chairman for fuel-cell introduction in mining requested cooperative meetings to share information and harmonize the introduction of fuel cells in mining between North America and Europe. The symposium also fostered continued industry interest for funding new hydrogen use projects.
- The development project for an underground mine loader that uses fuel cells is at the vehicle testing stage, at the Caterpillar proving grounds in Tucson, Arizona. Mining application tests will follow at NRCan's Experimental Mine in Val-d'Or, Quebec.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

TRANSPORTATION RESEARCH AND DEVELOPMENT:
Hybridization of a Load-Haul-and-Dump Mining Vehicle

Objective: To build and test a prototype diesel/electric hybrid Scooptram®, also known as a Hybrid-Load-Haul-and-Dump (H-LHD) Mining Vehicle.

The Hybridization of a Load-Haul-and-Dump Mining Vehicle project consists of establishing and verifying the potential to use diesel/electric hybrid technology in the mining industry. It will involve the development of a reliable and efficient hybrid power plant for underground applications that will be subsequently adapted to a full line of mining equipment.

The first step of the project is to select the configuration and components for the hybrid power plant and then work out engineering details that will enable component integration into the H-LHD. The next step following fabrication is optimization of vehicle design, which will make the Scooptram effective and reliable while keeping gas emissions such as diesel particulate to a minimum.

Comparison of the emission levels (respirable combustible dust, elementary/organic carbon, CO, NO, NO_2, SO_2 and O_2; size, distribution and characterization of diesel particles) of the hybrid LHD and a conventional LHD will follow. GHG emissions from the hybrid system are expected to decrease by at least 35 percent. The CANMET Mining and Mineral Sciences Laboratories will advise on the proper size of the exhaust purifier to optimize results. The H-LHD prototype vehicle will then be transferred to participating mines to determine if performance is adequate.

Key 2006–2007 Achievements

- The final choice of the configuration and the components was made.
- The engineering details of the integration of all the components were done.
- The H-LHD was manufactured and is ready to be tested.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

ALTERNATIVE TRANSPORTATION FUELS: Ethanol Expansion Program

Objective: To expand fuel ethanol production and use in Canada.

The Ethanol Expansion Program (EEP), co-managed by NRCan with Agriculture and Agri-Food Canada (AAFC), is contributing to the expansion of ethanol production and use in Canada, and the reduction of transportation GHG emissions. The program provides contributions, with repayment terms, towards the construction costs of new ethanol production facilities or the expansion of existing ones.

The intermediate outcomes of the EEP are expanded ethanol production, increased consumer adoption of ethanol and more markets for ethanol fuels in Canada. The longer-term outcome is a reduction of GHG emissions from the transportation sector (as ethanol replaces conventional fuels). EEP achieved 0.3 Mt of GHG reductions in fiscal year 2006–2007.

Key 2006–2007 Achievements

- In 2006–2007, four new ethanol plants that were allocated $51 million under the EEP were completed and started producing fuel ethanol. These four plants added 480 million litres (L) to the ethanol production capacity in Canada. The annual capacity had been 200 million L.
- Four more ethanol plants started construction under the EEP in 2006–2007. These plants have a combined production capacity of 390 million L annually.
- NRCan represented and coordinated the federal government presence at two ethanol plant openings.

For more information:
vehiclefuels.gc.ca

ALTERNATIVE TRANSPORTATION FUELS: Future Fuels Initiative

Objective: To increase Canada's fuel ethanol production and use in the transportation sector.

The Future Fuels Initiative, co-managed by NRCan with AAFC, targets motorists, provinces and territories, and industry stakeholders. The main activities are federal-provincial policy coordination, industry consultation, public awareness campaigns and analytical work on feed stocks, production costs, emissions and socio-economic impacts.

Key 2006–2007 Achievements

- Completed 5 bio-diesel workshops for fleet managers and mechanics with over 120 participants.
- Co-lead in the development of the Government of Canada's Renewable Fuels Strategy in coordination with Environment Canada and AAFC. The result was regulation of renewable fuels, a $200-million AAFC capital program for farmer participation in renewable fuels production and a 2007 Budget announcement for $2 billion for renewable fuels.
- Conducted five life-cycle emission studies on renewable fuels pathways using GHGenius.

For more information:
vehiclefuels.gc.ca

ALTERNATIVE TRANSPORTATION FUELS: Biodiesel Initiative

Objective: To support increased biodiesel production and use in Canada's transportation sector.

The Biodiesel Initiative was initially designed to support the Government of Canada's proposed target of 500 million L of biodiesel production annually by 2010. The work done under this initiative also supports the Government of Canada's implementation of a Renewable Fuel Standard that requires 2 percent renewable content in diesel fuel by 2010 at the earliest and 2012 at the latest.

The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2006–2007 Achievements

- The *Assessment of Canadian Biodiesel Distribution Infrastructure* study was completed. This study was designed to address potential distribution infrastructure roadblocks and proposed solutions and options to ensure sustainable growth of the Canadian biodiesel industry.
- A demonstration project that evaluated biodiesel use in agricultural equipment was conducted. This demonstration studied the use of biodiesel in six Ontario farms. Blends of 5 percent and 20 percent biodiesel were used, and data on fuel efficiency, emissions and maintenance/operational issues were collected.
- Five workshops for fleet managers and engine mechanics provided information about the purchase, handling, storage and use of biodiesel.
- A fuel testing study was conducted. It provided data on the suitability of biodiesel and renewable diesel for use in Canadian climate conditions, particularly cold weather applications. The results will be used to inform the biodiesel fuel selection process for the Alberta Biodiesel Demonstration Pilot.

For more information:
vehiclefuels.gc.ca

TRANSPORTATION TECHNOLOGIES: Canadian Transportation Fuel Cell Alliance

Objective: To demonstrate and evaluate processes for producing and delivering hydrogen to fuel-cell vehicles at fuelling stations, to develop and demonstrate hydrogen-fuelled vehicles, and to participate in the development of codes and standards.

NRCan's Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative that includes technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organizations. The CTFCA contributes to a reduction in GHG emissions by encouraging advances in hydrogen and fuel-cell technologies through demonstration projects. They evaluate the technical, economic and environmental feasibility of hydrogen fuelling options for fuel-cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards and certification and training programs.

Key 2006–2007 Achievements

- Four of the seven "Hydrogen Highway" fuelling stations in British Columbia are operational. The five Ford Focus fuel-cell cars completed the second of three years of on-road testing and evaluation in the Vancouver and Victoria areas.

- Initiated the development of "hydrogen highways" in Saskatchewan and Prince Edward Island. Each of these will include two or more hydrogen fuelling stations and several hydrogen-fuelled vehicles.
- Installed a hydrogen fuelling station at NRCan's Booth Street complex in Ottawa, Ontario to provide fuel for the three Ford internal combustion engine shuttle buses that are operated on Parliament Hill by the Senate.
- Published the new Canadian Hydrogen Installation Code as a National Standard of Canada. The Code will govern the installation of hydrogen-generating equipment, hydrogen-using equipment such as fuel cells, hydrogen-dispensing equipment, hydrogen storage containers, hydrogen-piping systems and related accessories.

For more information:
nrcan.gc.ca/es/etb/ctfca/ index_e.html

TRANSPORTATION TECHNOLOGIES: Hydrogen, Fuel Cells and Transportation Energy Program

Objective: To develop and deploy hydrogen, fuel cell and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth, and extend the life span of Canada's energy resource base.

The Hydrogen, Fuel Cells and Transportation Energy Program, in partnership with industry, works with stakeholders in the domestic and international hydrogen and transportation industries. These include original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the United States Department of Energy and the International Energy Agency.

Highlights of the program's work include the following:

- supporting Canadian industry in developing a water electrolysis technology for the production of hydrogen from clean renewable energy sources
- working with Canada's fuel cell industry over the last 20 years and establishing Canada as a world leader in fuel cell and refuelling technologies. For example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- supporting student vehicle challenges since the 1980s and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels
- supporting the development of fuel technologies for alternative transportation

Key 2006–2007 Achievements

- Developed a regenerative braking system that is coupled to a lithium-ion battery.
- Demonstrated a 100-kilowatt flywheel energy storage system.
- Improved cell efficiency and lowered costs of water electrolysis.
- Reduced the weight and increased the laminate strength of pressure cylinders for hydrogen storage.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/hyfate_e.htm

CHAPTER 7

Renewable Energy

RENEWABLE ENERGY USE

In 2005, renewable sources accounted for approximately 61 percent of the Canadian installed electricity capacity (see Table 7-1). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

Hydro-Electricity

Hydro-electricity is a renewable form of electricity that is generated from a system or technology that uses a mechanical method to capture and convert the potential energy of water.

Hydro is the main source of electricity in Canada, accounting for approximately 60 percent of the electricity generated in 2005. Canada's hydro supply is dominated by large-scale projects that were developed by electric utilities. Of the 72 000 megawatts (MW) of installed hydro capacity, approximately 3200 MW comes from small hydro sites (less than 50 MW), about 2.7 percent of Canada's total installed electricity capacity. Significant potential remains for additional hydro-electric development in Canada, in most provinces and territories.

Biomass

Bioenergy is a renewable source of energy derived from the conversion of materials of either living organisms or metabolic by-products. Canada has an abundant supply of many types of biomass, which is important in the production of energy, biofuels, materials and chemicals. The two largest sources of biomass supply in Canada come from forestry and agricultural operations.

The typical biomass supply is derived from

- forestry – mill or pulp and paper residues, black liquor from the pulping process, forest residue, forest management thinnings and short rotation crops
- agriculture – agricultural crops, crop residue, processing residues, algae and aquatic biomass
- other organic waste – animal waste such as manure from feed lots, municipal solid waste and industrial wastes

Canada is using approximately 6 percent of its energy demand from bioenergy. This amount of renewable bioenergy ranks second to hydro power (which generates 11 percent of Canada's energy). Most of the bioenergy being produced is in the form of industrial process heat, electricity, steam and residential space heating.

TABLE 7-1

Electricity Generation Capacity From Renewable Sources (Includes Hydro-Electricity)

Year	Renewable electricity generation capacity (megawatts)	Percent of total capacity
1990	59 557	58
1991	61 116	58
1992	62 895	58
1993	63 114	56
1994	63 175	56
1995	66 542	57
1996	67 101	59
1997	68 202	61
1998	68 340	62
1999	68 686	62
2000	69 005	62
2001	68 734	61
2002	70 895	62
2003	72 160	62
2004	72 783	62
2005	74 373	61

Source: Statistics Canada catalogue 57-206-XIB

TABLE 7-2

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal power	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Biodiesel
	Ethanol from biomass

The pulp and paper industry is Canada's major producer and user of bioenergy. Heat and electricity produced by industry, electricity generated by independent power producers, and residential wood heat are all considered commonplace in Canada's energy mix. As an example, approximately 3 million Canadian households use wood for home heating. Roundwood is typically used but alternatives include wood chips and pellets. Home eating with wood usually takes the form of stand-alone wood stoves, wood furnaces with hot-water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters.

Biogas and landfill gas (methane rich gases that are derived from manure, animal processing wastes, other agricultural residues and municipal waste) for energy production is just emerging and contributed just over 100 MW of power in 2006.

Biomass also shows potential as a feedstock for liquid fuels. Approximately 200 million litres of fuel ethanol are produced annually in Canada from cereal grain and corn. Biodiesel is also produced in small quantities but production is increasing. It is accepted that Canada has potential to increase its bioenergy production in a sustainable manner.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is 1 or 2 metres (m) below the surface remains fairly constant—between 5°C and 10°C. This temperature is warmer than the air during the winter and cooler than the air in the summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, a ground-source heat pump is known as an earth energy system (EES).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution or water, that circulates within an underground loop. The EES then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

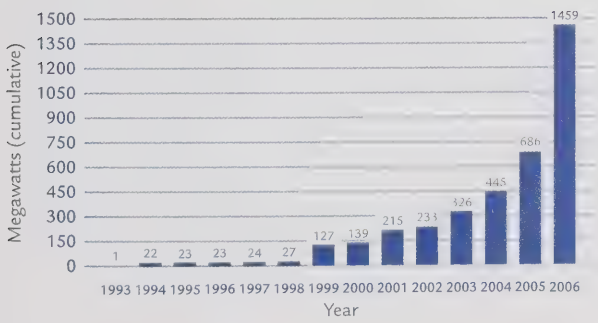
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with potential estimated at more than 100 000 MW. As of December 2006, a total of 1460 MW of wind power were installed in Canada, making it the thirteenth country that has reached the 1000 MW milestone and the twelfth largest nation in terms of installed wind energy capacity. 2006 was a record year for Canadian wind power with an increase of 776 MW from last year's level of 683 MW, which is a 113 percent increase. Recent policy developments have spurred record growth in the Canadian wind generation industry (see Figure 7-1). Wind energy currently accounts for approximately 0.7 percent of Canada's total electricity generation, up from 0.4 percent in 2005.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

FIGURE 7-1

Canadian Wind Power Capacity, 1993 to 2006



Source: Canadian Wind Energy Association

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies – Buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems – Solar radiation is converted into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems – Solar radiation is used to produce electricity.

The Canadian solar thermal installed capacity in 2005 was 419 000 m^2 or 290 $MW_{thermal}$. The domestic market increase has averaged 17 percent annually since 1998. In 2005, the solar thermal collector market in Canada was 61 500 m^2 compared with 53 600 m^2 in 2004.

The Canadian total photovoltaic (PV) installed capacity in 2006 was 20.5 MW with a sustained domestic market growth that has averaged 22 percent annually since 1992. In 2006, the PV module market in Canada was 3.75 MW compared with 3.68 MW in 2005.

Module prices declined from $11.09/W in 1999 to $5.36/W in 2006. This is an average annual price reduction of 9 percent. Twelve manufacturers in Canada reported revenues from manufacturing operations related to system sales of $137 million and the addition of 55 jobs in 2006. The PV business in Canada is valued at $205 million and employs 1030 people.

Natural Resources Canada (NRCan) delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

RENEWABLE ENERGY PROGRAMS:
Wind Power Production Incentive

Objective: To support the installation of 1000 MW of wind energy capacity or the production of 2.6 terawatt hours by March 31, 2007.

Under the Wind Power Production Incentive (WPPI), electric utilities, independent power producers and other stakeholders could qualify for an incentive averaging $0.01/kilowatt hour (kWh) on electricity produced from wind over a 10-year period. The commitment period for new wind energy projects under the program came to an end on March 31, 2007.

Key 2006–2007 Achievements

- Three wind energy projects were commissioned in fiscal year 2006–2007: two are in Ontario and one is in Alberta. These projects represent approximately 173 MW of wind energy capacity and a financial contribution of more than $51 million over 10 years.
- Since WPPI's introduction in 2002, the program has supported 924 MW of new capacity, which included 22 projects and a financial commitment of approximately $314 million.

For more information:
canren.gc.ca/wppi

RENEWABLE ENERGY PROGRAMS:
Initiative to Purchase Electricity From Emerging Renewable Energy Sources

Objective: To purchase electricity from emerging renewable energy sources (ERES) certified by a third party as having low environmental impact, with the objective of reducing GHGs and other air pollution emissions associated with federal electricity consumption.

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Saskatchewan and Prince Edward Island. The Government of Canada pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2006–2007 Achievements

- Approximately 90 gigawatt hours (GWh) of electricity were generated from ERES in Ontario through an agreement with Energy Ottawa.
- Approximately 57.4 GWh of electricity are generated annually from ERES for federal facilities in Alberta, Saskatchewan and Prince Edward Island. As a result, GHG emissions were reduced by approximately 50 000 tonnes.

For more information:
reed.nrcan.gc.ca

RENEWABLE ENERGY PROGRAMS:
Renewable Energy Deployment Initiative

Objective: To stimulate the demand for renewable energy systems by helping the supply industry with its marketing and infrastructure development, including the provision of financial incentives.

The Renewable Energy Deployment Initiative (REDI) targets four systems: solar water heating, solar air heating and cooling, earth energy, and high-efficiency, low-emission biomass combustion. REDI promotes these systems in the business, federal and industrial markets through various means: a financial incentive, industry infrastructure development, a partnership with a utility coalition, market assessment, and information provision and awareness-raising activities.

Key 2006–2007 Achievements

- The program experienced a record level of interest, completing 298 projects at the end of fiscal year 2005–2006 and receiving over 1000 applications (see Table 7-3). Two market documents were published: *The REDI Strategic Business Plan to March 2007* and *A Survey of Active-Solar Thermal Collectors, Industry and Markets in Canada*.
- REDI supported a solar domestic hot water system. It was the first packaged system of its type to receive Canadian Standards Association certification in Canada.

For more information:
nrcan.gc.ca/redi

TABLE 7-3

REDI for Business Projects Completed, 1998 to 2005

Fiscal year	Number of projects completed	Estimated GHG reduction (tonnes CO_2/yr)	Client investment ($)	Federal incentive ($)
1998	10	2 909	1,428,063	176,392
1999	70	329	689,633	189,910
2000	131	6 370	2,170,918	327,078
2001	51	23 465	6,708,120	1,362,399
2002	50	7 643	5,048,607	956,600
2003	119	33 975	25,060,504	3,226,694
2004	65	47 446	11,200,943	2,250,421
2005	298	18 987	21,494,497	2,920,750
Total	**794**	**141 124**	**73,801,285**	**11,410,244**

RENEWABLE ENERGY PROGRAMS:
Photovoltaic and Hybrid Systems Program

Objective: To support the development and application of solar photovoltaic technologies in Canada.

The Photovoltaic and Hybrid Systems program contributes to increasing the use of photovoltaic (PV) energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs. In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes research and development (R&D) activities and fosters information exchanges. This leads to the adoption of PV-hybrid systems that produce electricity from solar energy and another energy source; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated PV technologies and systems; and facilitates the development and adoption of harmonized standards and codes for micropower systems in Canada.

Key 2006–2007 Achievements

- Published the PV and solar resource maps for Canada. These "on-line" Web maps were unveiled on November 3, 2006, at the Canadian Solar Industries Association annual conference in Ottawa. The maps give estimates of the electricity that can be generated by PV arrays and of the mean daily global insolation for any location in Canada. The maps are complemented by a municipality database that gives PV potential data for more than 3500 municipalities. The maps and database are important new tools that allow users to rapidly assess the potential of PVs throughout Canada and to examine how this potential varies with location, time of year and PV panel orientation.
- A research partnership with universities and industry has been established to optimize the use of renewable energy in buildings in Canada. This Solar Buildings Research Network is headquartered at Concordia University and brings together top Canadian researchers in solar energy and buildings to develop the solar-optimized homes and commercial buildings of the future. The network will also develop and implement a strategy to effectively transfer this knowledge to architects, manufacturers and home builders and utilities. See www.solarbuildings.ca.
- The first Canadian interconnection standard was adopted in 2006. This new national standard of Canada (CAN/CSA-C22.2 No. 257-06) was issued by the Canadian Standards Association under Part II of the *Canadian Electrical Code* and specifies the electrical requirements for safe interconnection of inverter-based micro-distributed resource (micro-DR) systems connected to 600 volt (nominal) or less distribution systems (single or three phase). Program support and expertise in the area of PV inverter-based interconnection established the technical foundation for the national standard.

For more information:
cetc-varennes.nrcan.gc.ca/en/er_re.html

RENEWABLE ENERGY PROGRAMS:
Bioenergy Technology Program

Objective: To support efforts by Canadian industry to develop bioenergy technologies.

Technologies supported by the Bioenergy Technology program include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products in domestic and foreign markets.

Key 2006–2007 Achievements

- BIOX Corporation of Oakville, Ontario, completed the construction and commissioning of a biodiesel production facility in Hamilton, Ontario, that will produce 60 megalitres (ML) annually. The facility is now in continuous full commercial production. This innovative technology was developed at the University of Toronto and licensed to BIOX with technical and funding support from NRCan, including the demonstration of a 1-ML per year pilot plant. The technology is unique in that it can convert low quality oils and greases into a high quality biodiesel fuel with lower capital and operating costs than competing technologies. Sustainable Development Technology Canada provided funding support to this facility, which is the largest biodiesel production facility in Canada, and one of the few in the world capable of running on multiple triglyceride feedstocks.
- In February 2007, the United States Department of Energy announced that it would be investing US$385 million in six biorefineries over the next four years. The six successful consortiums were selected after rigorous technical and economic reviews. Iogen Corporation of Ottawa, Ontario, was one of the six companies chosen. Iogen technology makes it economically feasible to convert biomass into cellulose ethanol by using a combination of thermal, chemical and biochemical techniques.
- NRCan has played a key role in a gasification project in Kamloops, British Columbia. A gasification technology developed by Nexterra Energy was installed at a plywood mill in Heffley Creek, British Columbia, that is owned by Tolko Industries. This energy plant is the first application of its type in the North American forest industry to make use of green technologies that can convert hog fuel waste produced at mills to a renewable energy source that can replace natural gas in lumber kiln drying applications. As a result of this successful commercial demonstration, Nexterra has announced that other projects such as Dockside Green in Victoria, British Columbia, will be utilizing its technology.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/Research%20Programs/program_bioenergy_e.htm

RENEWABLE ENERGY PROGRAMS:
Science and Technology in Renewable Energy

Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) aims to improve the economics and efficiency of renewable energy technologies, including wind energy, small and low-head hydro, ocean energy, solar thermal and energy storage. It is actively involved in R&D to support the growth of the renewable energy industry in Canada. Growth will be achieved by

- identifying and accelerating strategic R&D
- fostering the commercialization of new technologies
- identifying and developing opportunities for renewables integration
- developing infrastructure to support innovation, such as codes, policies and standards
- developing links between utilities, industry and academia
- conducting resource assessments
- supporting training and education
- disseminating results and findings
- supporting policy and programs
- engaging in international cooperation through the International Energy Agency

Key 2006–2007 Achievements

- Construction began in 2005 on the Drake Landing Solar Community, a 52-home subdivision in Okotoks, Alberta, south of Calgary. This seasonal project stores solar thermal energy. It was designed and led by CETC to capture solar energy in the summer and store it for use in the winter. The solar district heating system will meet 90 percent of the community's needs for residential space heating. This result is unprecedented anywhere in the world. In 2006–2007, all homes were sold and 40 homes were occupied, with 25 percent of solar collectors online and the remainder installed. The final commissioning is scheduled for September 2007.
- CETC works to improve Canadian standards for renewable energy technologies. In 2006–2007, CETC helped form the Canadian National Technical Committee for Wind Turbine Standards. The committee worked on adopting and adapting a set of International Electrotechnical Commission (IEC) standards for Canadian use. The existence of these standards will significantly improve the Canadian wind regulatory framework and facilitate the commercial transactions between Canada and other countries. In addition, CETC represents Canadian interests (such as cold climate requirements) internationally in the development of future IEC standards for wind energy. CETC also led the development of Canada's first certification program for solar domestic hot water systems (SDHW), which will allow these systems to be installed anywhere in Canada. The first SDHW system has been certified.
- CETC was the Canadian Executing Agency for the Canadian International Development Agency's Canada Climate Change Development Fund ($2 million) contribution to a small hydro project that was completed in China. The project used automation equipment to improve the operational efficiency of small hydro plants. The project maximized river basin power production by using optimized equipment and hydrological modeling. It also increased energy efficiency and power production by using a new and enhanced turbine design. On average, a 10 to 12 percent increase in energy production from the small hydro generating plants was achieved. That increase now serves approximately 18 000 additional households.

- A Vanadium-Based Redox Battery System with a 3.3-kW, 3-hour storage capacity was purchased by the National Research Council and installed at CETC. CETC has been operating the battery and developing testing programs with partners to assess the performance of the system. Work is progressing towards application-specific testing (e.g. wind/storage simulations).

- Canada's ocean energy resources are among the largest in the world. A new feasibility study was started to assess the viability of a tidal power plant demonstration, located on the northeast coast of the Queen Charlotte Islands in British Columbia.

For more information:
sbc.nrcan.gc.ca

RENEWABLE ENERGY PROGRAMS: Canadian Biomass Innovation Network

Objective: To develop sustainable and cost-effective technologies in bioenergy, biofuels, bioproducts and industrial bioprocesses for market acceptance, utilizing biomass resources in a sustainable and responsible way.

The Canadian Biomass Innovation Network (CBIN) supports strategic R&D in the areas of bioenergy, biofuels, bioproducts and industrial bioprocesses to displace Canada's fossil fuel energy consumption; directly or indirectly reduce GHG emissions; and seed the sustainable development of Canada's bio-based economy.

CBIN is a horizontal program developed and managed by five federal departments: Agriculture and Agri-Food Canada, Environment Canada, Industry Canada, National Research Council and NRCan.

Key 2006–2007 Achievements

- Polylactide, a rigid and transparent polymer made from lactic acid, is presently not cost-competitive with petroleum-based polymers and is too brittle for many packaging applications. During the year, the network demonstrated that the addition of starch in a blend leads to a much more homogeneous product, with highly improved ductility, leading to potential new applications.

- A single window, interactive, Web-based biomass information portal is being completed. It will provide resources and tools that can be used by investors, policy makers and the research community to learn more about the industrial uses of herbaceous and woody biomass.

- In February 2007, Tembec announced that the Anaerobic Digester they installed on their mill effluent with assistance from NRCan and Technology Early Action Measures is now operating at full design capacity. They emphasized that the system has three benefits. The system provides methane gas that displaces 90 percent of the natural gas in the mill's pulp driers, the quality of the mill effluent is drastically improved, and the amount of sludge that goes to landfill is significantly reduced.

- The life cycle and impact assessment methodology
was adapted to the Canadian pulp and paper industry for continuous environmental improvement, strategic planning and forest biorefinery assessment.

For more information:
cbin.gc.ca

CHAPTER 8

Federal House in Order

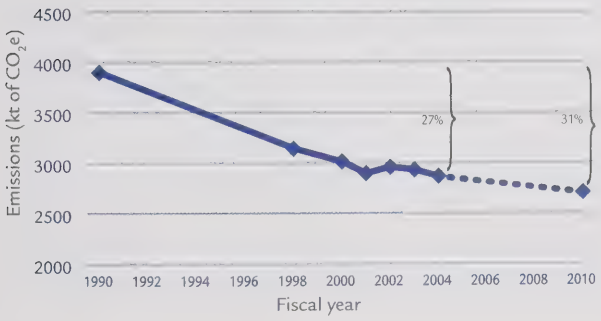
INTRODUCTION

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved an emissions reduction of 27 percent. The Government of Canada plans to reduce its net emissions by an additional 6 percent by 2010 (see Figure 8-1).

FIGURE 8-1

GHG Emissions Reductions From Federal Operations, 1990 to 2010



The Government of Canada will achieve its goal through additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Also, the Government of Canada can help "create the market" for certain new technologies that are on the verge of becoming viable. The departments that create 95 percent of government GHG emissions were assigned target shares for emission reduction. The level of progress of each department against their target shares is combined into one figure for the Government of Canada.

The task of target sharing entails assigning targets to the 11 organizations that produce the most emissions. The targets are based on the emission-reduction opportunities identified within each organization. Between 2001 and 2006, Natural Resources Canada (NRCan) had the lead role in managing this task and provided programs and support to departments and agencies to help them achieve their targets. In 2006, the responsibility was transferred to the Office of Greening Government Operations in Public Works and Government Services Canada. The leadership component of the Federal House in Order initiative encourages the reduction of all federal emissions by encouraging the participation of the departments, agencies and Crown corporations that were not designated with a target.

FEDERAL HOUSE IN ORDER LEADERSHIP MEASURES – BUILT ENVIRONMENT

Objective: To help Government of Canada organizations implement energy efficiency improvements that lead to reduced energy use, GHG emissions and operating costs.

The Federal House in Order Leadership Measures program develops and delivers products and services to federal organizations that demonstrate an interest in improving the efficiency of their building energy use. Products may include case studies, workshops, technical information, model procurement documents and a list of qualified private-sector energy management firms that can provide energy performance contracting services. Services may include facilitation such as energy management technical advice, program policy advice and procurement services to assist organizations at implementing energy efficiency improvements.

Key 2006–2007 Achievements

- Canadian Forces Base Kingston in Kingston, Ontario, is proceeding with an energy efficiency retrofit project. The project is expected to save $2.4 million in energy costs annually. The private sector is investing $21 million.
- The private sector made new and incremental investments of $30 million in Federal Building Initiative (FBI) projects.
- The FBI awarded energy efficiency projects that will reduce the federal government's annual utility bills by $3.7 million.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

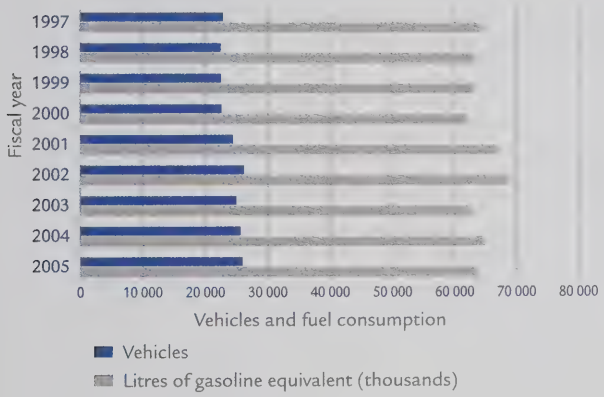
FEDERAL FLEET INITIATIVE

Objective: To help federal government organizations increase the energy efficiency of their fleets and reduce the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.

The Federal Fleet Initiative provided tools and information to federal fleet managers and drivers to help them respond to climate change and to improve the overall efficiency of their fleets. NRCan administered this initiative through an interdepartmental committee that includes the 11 largest emitting federal organizations. This committee discusses fleet management and operational issues and activities.

FIGURE 8-2

Federal Fleet Size and Fuel Consumption, 1997 to 2005



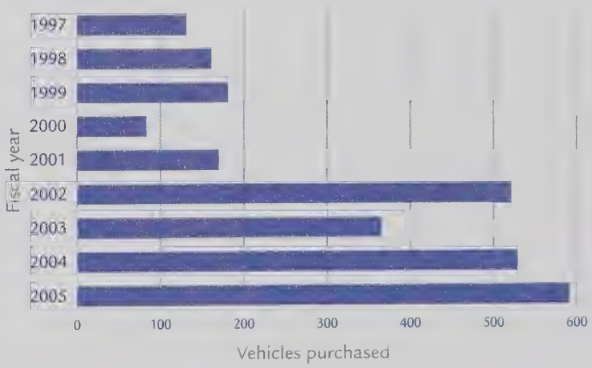
Key 2006–2007 Achievements

- Increased the penetration of ethanol-85 (E85) fuel across the federal fleet by subsidizing 471 599 litres (L) of E85 fuel to federal fleets (as of April 2007).
- Trained 1208 federal vehicle operators in fuel efficient driving techniques at workshops and on-line.
- Assisted in purchasing 51 Leadership Vehicles (E85 and hybrid vehicles).
- Increased the penetration of biodiesel fuel across the federal fleet by subsidizing 5100 L of B-100 fuel to federal fleets (as of April 2007).

For more information:
oee.nrcan.gc.ca/communities-government/transportation/federal/mandate.cfm

FIGURE 8-3

Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2005



CHAPTER 9

General Programs

OUTREACH

Objective: To increase Canadians' awareness and understanding of energy efficiency information and supporting services and to encourage Canadians to take action.

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, contests, recognition awards and the Office of Energy Efficiency (OEE) Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. The activities also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

Key 2006–2007 Achievements

- In 2006–2007, over 1 million OEE publications and information tools were distributed. This number is significant but is a decrease from the previous year.
- Efforts in 2006–2007 focussed on the launch of the new ecoENERGY suite of programs to promote smarter energy use.

For more information:
oee.nrcan.gc.ca/corporate/programs.cfm#Outreach

RETSCREEN® INTERNATIONAL CLEAN ENERGY DECISION SUPPORT CENTRE

Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of potential projects.

Key 2006–2007 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 107 000 people in 217 countries. This number is growing at a rate of 500 new users every week. More than 131 colleges and universities worldwide are now using RETScreen for education.
- Released the beta version of a new software tool to evaluate energy efficiency measures in skating and curling rinks.
- Initiated beta testing of RETScreen Version 4. In version 4, the software includes an array of financially viable clean power, heating and cooling technologies and energy efficiency measures. Collaborated with NASA to increase the amount of climate data required by RETScreen to cover the entire surface of the planet. Coordinated with the Renewable Energy & Energy Efficiency Partnership to translate RETScreen into 25 languages that are used by two-thirds of the world's population.

For more information:
www.retscreen.net

PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT

Objective: To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

The Program of Energy Research and Development (PERD) budget for 2006–2007 was approximately $56.6 million. Natural Resources Canada (NRCan) allocated $40.7 million to energy R&D programs managed and performed in the department, approximately 50 percent of which contributed to improved energy efficiency and the integration of renewable energy sources in Canada. The remaining $16 million has been allocated to 12 federal departments and agencies that are PERD partners.

Efficiencies are sought in energy production, distribution and end-use. Production encompasses both fossil fuels and alternative sources, including biomass. Examples of funded projects are included in the performance reporting in Chapters 3 to 7 of this report.

During 2006–2007, based on recommendations of an advisory panel and as mandated in Budget 2005, the management of energy science and technology was reviewed, streamlining the delivery along the innovation chain from basic research and applied research to pilot plants and demonstrations, ensuring faster market access to technologies developed with federal funds.

For more information:
www2.nrcan.gc.ca/ES/OERD/english/

CLIMATE CHANGE TECHNOLOGY AND INNOVATION
Research and Development

Objective: To advance promising greenhouse gas (GHG) technologies through R&D, promote demonstration and early adoption initiatives to achieve long-term GHG reductions, and strengthen Canada's technology capacity.

Implemented in 2003 with $115 million in federal funding over five years, technology innovation research and development (T&I R&D) is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of advanced end-use efficiency technologies in buildings, transportation and industry, decentralized energy production (including renewables), biotechnology, the hydrogen economy and cleaner fossil fuels—looking for efficiencies in bitumen and heavy oil, unconventional gas supply and clean coal and carbon capture. Expenditure Review reduced funding to $109 million.

The T&I R&D budget for 2006–2007 was $31.5 million. NRCan allocated $24.1 million to energy R&D programs managed and performed in the department. Key NRCan R&D achievements contributing to improved energy efficiency in Canada are included in the performance reporting in Chapters 3 to 7. The remaining $7.4 million was allocated to seven federal departments that are T&I R&D partners.

A result achieved through investment in energy efficiencies over many years (both PERD and T&I R&D funding) is the conversion to commercial operation of an experimental biomass to energy plant (methane recovery) in the pulp and paper industry, based on black liquor, a difficult to handle residue. The plant supplies up to 90 percent of the mill's heating requirements, displacing 6 million cubic metres of natural gas per year, saving 11 000 tonnes of CO_2 emissions.

CHAPTER 10

Cooperation

INTRODUCTION

This chapter describes Natural Resources Canada's (NRCan's) cooperation with provincial and territorial governments and internationally on energy efficiency and alternative energy (EAE) during the reporting period. Examples of program cooperation on specific EAE initiatives are in the "Key Achievements" sections in earlier chapters.

Note that municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (for example, in anti-idling projects), and that NRCan also participates in ventures led by municipal organizations (for example, Green Municipal Fund, as explained in the accompanying textbox) and by provincially/territorially regulated electricity utilities and provincially regulated natural gas utilities.

Green Municipal Fund

- The Green Municipal Fund was created in 2000. The Government of Canada signed an agreement with the Federation of Canadian Municipalities (FCM), a non-profit organization, to deliver the Green Municipal Fund. The federal endowment to the fund at present totals $550 million. The fund supports municipal government action to reduce greenhouse gases, cut pollution and improve the quality of life.
- Under the agreement, the Government of Canada (represented by NRCan and Environment Canada) participates in governance of the fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council. The FCM Board of Directors approves projects based on the council's recommendations.

Several institutions in Canada address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies and various associations and energy supply utilities. The centres facilitate access to data on energy use in the industry, transportation and building sectors, monitor the quality of data, and investigate methods to improve data collection and analysis. The goal of another institution, the Canadian Centre for Energy Information, is to engage North Americans in critical inquiry and discussion on energy and energy-related issues affecting their quality of life.

A third institution, the Canadian Energy Efficiency Alliance, is a non-profit organization established to promote the efficient use of energy in Canada.

There are two national consultative bodies in the area of energy efficiency:

- Assistant Deputy Minister Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers
- Office of Energy Efficiency (OEE) National Advisory Council on Energy Efficiency (NACEE)

In 2004, federal, provincial and territorial energy ministers decided that the ASCEE should be formed and tasked with establishing a coordinated and complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held seven meetings in 2006–2007, with members representing the federal, provincial and territorial governments.

There are three working groups under the auspices of the ASCEE:

- Originally formed in 2003, the Demand Side Management Working Group (DSM WG), now reports to the ASCEE and has members representing NRCan, industry, and seven provinces and territories. The DSM WG has initiated studies, for example, related to DSM potential in Canada, best practices in performance measurement and reporting and regulatory frameworks.
- The ASCEE sponsored the formation the Transportation Working Group on Energy Efficiency (TWGEE) in 2005. Its mandate is to seek opportunities for stronger cooperation among governments in harmonizing policies and programs that can affect energy efficiency and to make recommendations to ministers on the need for government action. The TWGEE comprises senior federal and provincial government officials.
- A third working group, the Industry Working Group on Energy Efficiency, was formed in 2006 to promote information exchange among industrial energy end-users and authorities, agencies, utilities and jurisdictions involved in the design, development and delivery of industrial energy efficiency programming in Canada.

NRCan created NACEE in April 1998 to advise the OEE on the most effective way to achieve its mission. The membership of NACEE is drawn from across Canada and all economic sectors and includes provincial/territorial officials and representatives of electricity and natural gas utilities. The members can comment on the OEE's business plan and programs. NACEE met three times during 2006–2007.

FEDERAL-PROVINCIAL AND FEDERAL-TERRITORIAL COOPERATION

Interest continues to grow in energy efficiency as a means of maximizing service from the existing energy supply capacity in the country. Provincial and territorial governments helped to deliver EAE programs to reduce energy costs, address climate change, increase competitiveness, improve air quality and generate economic opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, governments cooperated on energy efficiency in general and on specific program initiatives.

All provinces and territories engage in energy efficiency activities and/or deliver programs in their jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency. For example, Energy Solutions Alberta, under Climate Change Central, is a focus for information and action on energy efficiency and conservation in Alberta. In Saskatchewan, the mandate of the Office of Energy Conservation is to encourage and support voluntary action by the public and by industry through public information, energy efficiency demonstrations, and the development of pilot projects. The Ontario Power Authority's Conservation Bureau provides leadership in planning and coordinating measures for

electricity conservation and load management. The Energy Efficiency and Conservation Agency of New Brunswick seeks to influence efficient energy use, help control energy expenses and lessen the impact of energy use on the environment. The Canada-Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power. The Arctic Energy Alliance promotes energy efficiency and renewable energy in the Northwest Territories. The Nunavut Energy Centre promotes energy efficiency and renewable energy in Nunavut.

The Building Energy Codes Collaborative

The Building Energy Codes Collaborative (BECC) is a provincial-territorial-federal committee supported by the Council of Energy Ministers, ASCEE and NRCan. BECC consists of representatives from provincial/territorial code and energy ministries, departments and agencies; NRCan; and the Canadian Codes Centre.

The objectives of the BECC are to:

- provide a forum for provinces, territories and the federal government to support the update, regulatory adoption and implementation of the *Model National Energy Code for Buildings* (MNECB) as a document by authorities that have the jurisdiction
- work in cooperation with the provinces and territories and the Canadian Commission on Building and Fire Codes towards a national consensus on establishing energy efficiency in the code process
- explore other regulatory and/or programmatic instruments for increasing energy efficiency in new housing, including updating the Model National Energy Code for Houses
- seek political and financial support from the federal government, and both the energy and building code ministries in the provinces and territories, and engage their representatives in the process

The groundwork already laid by provinces and territories in the area of energy efficiency is a strong foundation to choose making a collaborative effort for the MNECB rather than pursuing individual regulatory paths.

NRCan and the BECC recognize that effective and influential partnerships are critical to the success of an updated MNECB that is adopted and implemented by provinces and territories. The membership and focused activity of the BECC itself is a signal of a high level of federal, provincial, and territorial collaboration on this initiative.

Cooperation Agreements

NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec provides for consultation and exchange of information between the two governments, coordination of EAE activities in Quebec, and the creation of opportunities for joint projects. The management committee established under the LOC reviewed policy and program developments, progress on joint program initiatives, and areas for further cooperation.

The LOC played a role in facilitating three activities in particular:

- management of the licensing agreement for local delivery of EnerGuide for Houses
- processing projects submitted to the EnerGuide for Existing Buildings and the Commercial Building Incentive Program by public organizations in Quebec. This cooperation framework is also being applied to other NRCan programs that target the Quebec public sector.
- management of an agreement that relates to the Programme d'intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in the Yukon, including

the establishment of the Canada-Yukon Energy Solutions Centre in Whitehorse, Yukon. The centre provides access to technical services and programs for the Yukon population and undertakes outreach and public education activities.

The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and provide opportunities for EAE projects. The Alliance is also the delivery agent in the Northwest Territories for R-2000. Through the contribution agreement with the Qulliq Energy Corporation, the Government of Canada contributes to the Nunavut Energy Centre, which promotes energy efficiency and renewable energy in Nunavut.

NRCan works cooperatively with Ontario's Ministry of Small Business and Entrepreneurship, the Independent Electricity System Operator and local distribution companies to provide energy management training to individual companies across the province through Dollars to $ense workshops.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a non-profit corporation funded by a multistakeholder base, including the Government of Alberta.

INTERNATIONAL COOPERATION

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products

International Energy Agency

The International Energy Agency (IEA), based in Paris, France, is an autonomous agency of the Organisation for Economic Co-operation and Development. The IEA conducts a comprehensive program of energy cooperation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. The IEA and its Governing Board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Co-operation (SLT) is the key committee on the policy side. The group analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil, and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. The OEE represents Canada on the EEWP.

Canada's international energy research and development (R&D) objectives are mainly advanced through the IEA's Working Parties, implementing agreements and the Committee for Energy Research and Technology, chaired by NRCan. Canada participates in 32 of the IEA's 40 implementing agreements, that is, R&D collaboration programs. NRCan spent $605,000 on IEA Implementing Agreements in 2006–2007, plus personnel expenses and travel. In many programs, this work has permitted acceleration of technology development in Canada that far exceeds the direct costs of collaboration.

Canada also cooperates with research centres in member countries on several agreements and programs on R&D and technology. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

Group of Eight

The Group of Eight (G8) Summit in 2005 established the Gleneagles Plan of Action that includes a number of actions in the area of EAE. While NRCan's participation in IEA and international mechanisms for standards harmonization responds to many of the listed activities, others are implemented through NRCan's EAE programs.

United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre–Varennes (CETC–Varennes) through cost- and task-shared collaborative ventures with other governments and multilateral organizations, and with technical support from more than 250 experts representing industry, government and academia. Key partners are the NASA's Langley Research Center and the Renewable Energy & Energy Efficiency Partnership. Other international partners include the Energy Unit of the United Nations Environment Program (UNEP) and the Solar and Wind Energy Resource Assessment project sponsored by the UNEP-Global Environment Facility.

China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on Climate Change and the Clean Development Mechanism. Energy efficiency is one area of cooperation identified in both MOUs.

Mexico

NRCan signed an MOU on EAE cooperation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and by enhancing trade and investment as well as technical and other exchanges related to energy-efficient products, energy management services and alternative energy goods and services.

Under the MOU on EAE, officials of Mexico's National Commission for Energy Savings (CONAE) participated in an industrial energy efficiency conference held in May 2005 in Ottawa. Also under the MOU, NRCan organized an energy efficiency workshop in cooperation with CONAE. The workshop was held in Puebla, Mexico in March 2006.

United States

NRCan and the United States (U.S.) Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism to advance harmonization of North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories.

Canada has been cooperating with the U.S. DOE under an MOU on energy R&D in the areas of fuel cells, fossil fuels, bioenergy, community systems and microgeneration, nuclear fission, and carbon sequestration.

North America

NRCan continues to participate with the U.S. and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards, and cooperation on trilateral energy efficiency labelling programs. In 2006–2007, work under NAEWG involved primarily coordinating the energy sector commitment to the Security and Prosperity Initiative. In addition to ongoing standards and program collaboration, a project was implemented to develop a North American approach to standby loss by electricity-using products.

The Canada-Mexico Partnership (CMP), established in 2004, serves as a mechanism for identifying policies for facilitating cooperation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society. Sustainable housing is a priority theme under the CMP. Canada Mortgage and Housing Corporation (CMHC) chairs a working group on sustainable housing technologies under the CMP within the framework of a Letter of Intent (LOI) with CONAVI, the Mexico national housing agency. The LOI provides the scope of the working group activities. NRCan participates as a member of this working group through CETC's Sustainable Buildings and Communities Group.

In 2006, under the CMP, NRCan and CMHC facilitated meetings between Mexican builders and developers and Canadian photovoltaic (PV) and solar domestic hot water companies. A PV grid-connect project was an area of common interest and a pilot project was carried out in 2007. Mexican stakeholders were interested in Canadian approaches to sustainable projects for entire neighbourhoods including standards for sustainable projects, decision-making tools and access to Canadian case studies. A workshop to facilitate this information exchange also took place in 2007.

Innovative financing for renewable energy and energy-efficient projects is an on-going theme under the CMP working group. Mexico is launching a "green mortgage" instrument and government and industry stakeholders want to learn more about financing instruments for renewable energy and energy efficiency features in housing. An element of this includes possible Clean Development Mechanism credits.

APPENDIX 1

NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2006–2007

(millions of dollars)

Energy Efficiency – Equipment	**$19.2**
Energy Efficiency Standards and Regulations	
Equipment Labelling and Promotion	
EnerGuide for Industry	
Energy Efficiency – Housing and Buildings	**$128.8**
R-2000 Standard and EnerGuide for (New) Houses	
EnerGuide for Houses and Retrofit Incentives	
Energy Science and Technology in Housing	
Commercial Building Incentive Program	
Industrial Building Incentive Program	
EnerGuide for Existing Buildings or the Existing Buildings Initiative	
Refrigeration Action Program for Buildings	
Intelligent Buildings	
Energy Science and Technology in Buildings and Communities	
Federal House in Order Leadership Measures – Built Environment	
Energy Efficiency – Industry	**$32.4**
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation)	
Industrial System Optimization Program	
Industry Energy Research and Development Program	
Clean Electric Power Generation	
Processing and Environmental Catalysis Program	
Enhanced Recycling for Minerals and Metals	
Supplementary Cementing Materials Program	
Mine Ventilation	

(millions of dollars)

Energy Efficiency – Transportation	**$10.5**
Marketing of Efficient Vehicles	
Motor Vehicle Fuel Efficiency Initiative	
Commercial Transportation and Energy Efficiency Fuel Initiative	
Freight Efficiency and Technology Initiative	
Canadian Lightweight Materials Research Initiative	
Federal Fleet Initiative	
Alternative Energy – Transportation	**$49.5**
Fuel Cell-Powered Mining Vehicles	
Hybridization of a Load-Haul-and-Dump Mining Vehicle	
Ethanol Expansion Program	
Future Fuels Initiative	
Biodiesel Initiative	
Canadian Transportation Fuel Cell Alliance	
Hydrogen, Fuel Cells and Transportation Energy Program	
Alternative Energy – Renewable Energy Sources	**$54.0**
Wind Power Production Incentive	
Initiative to Purchase Electricity From Emerging Renewable Energy Sources	
Renewable Energy Deployment Initiative	
Photovoltaic and Hybrid Systems Program	
Bioenergy Technology Program	
Science and Technology in Renewable Energy	
Canadian Biomass Innovation Network	
General Programs[1]	**$5.8**
Outreach	
RETScreen® International Clean Energy Decision Support Centre	
National Energy Use Database	
Total	**$300.2**

[1] Totals allocated for funding programs in Chapter 9 are reflected in the relevant program entries.

APPENDIX 2

Data Presented in Report

The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy-use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1997 to 2005*.

FIGURE 1-1: Energy Intensity and the Energy Efficiency Effect,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.97	0.91	0.89	0.87	0.84	0.85	0.85	0.84	0.81
Index of energy efficiency effect	1.00	0.98	0.97	0.96	0.96	0.92	0.93	0.91	0.89	0.87	0.87	0.86	0.87	0.88	0.86	0.84

* Index: 1990=1.00

FIGURE 1-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.00	1.03	1.05	1.09	1.15	1.17	1.20	1.20	1.25	1.29	1.27	1.31	1.33	1.36	1.38
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18	1.22	1.23	1.22

* Index: 1990=1.00

FIGURE 2-1: Volume of Monthly Import Documents

Month and year	Paper	Electronic
Apr. 06	5 696	44,497
May 06	5 837	49 937
Jun. 06	7 660	51 181
Jul. 06	6 681	46 486
Aug. 06	7 407	48 317
Sep. 06	6 240	48 572
Oct. 06	7 188	51 983
Nov. 06	2 712	48 904
Dec. 06	2 254	44 867
Jan. 07	2 424	42 660
Feb. 07	2 912	42 363
Mar. 07	2 372	52 409
Total	**59 383**	**572 176**

FIGURE 2-4: ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005

Appliance	1999	2000	2001	2002	2003	2004	2005
Dishwashers	0.56	1.57	9.66	29.77	56.50	80.95	90.80
Refrigerators	—	—	11.40	22.26	40.68	34.16	37.60
Washers	1.93	2.24	9.24	22.07	30.55	36.16	45.90

FIGURE 2-5: ENERGY STAR Awareness Levels in Canada, 2005

	Percent
Aware – non-aided	36
Aware – aided	80

FIGURE 3-1: Canadian Households by Type of Dwelling, 2005

Dwelling type	Number of households	Percentage
Single detached homes	7 083 709	56
Apartments	3 936 757	31
Single attached homes	1 320 470	11
Mobile homes	245 834	2
Total	**12 586 770**	**100**

FIGURE 3-2: Residential Energy Use by Purpose, 2005

Activity	Energy use (petajoules)	Percentage
Space heating	846.1	60
Water heating	248.2	18
Appliances	203.0	14
Lighting	68.4	5
Space cooling	36.5	3
Total	**1402.2**	**100**

FIGURE 3-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.14	1.18	1.25	1.22	1.28	1.32	1.32	1.34
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.12	1.08	0.99	1.03	1.08	1.04	1.08	1.12	1.10	1.09

* Index: 1990=1.00

FIGURE 3-4: Annual Heating Consumption for Houses* Constructed to Different Standards

Description	EnerGuide for Houses Annual Heating Consumption (GJ)
Typical existing house (1970)	216.81
Typical new house (2002)	146.27
Model National Energy Code house (2002)	112.10
R-2000 house	78.74

* 198-m^2 one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 3-5: Number of Households, Average Floor Space of New Houses and Energy Intensity Indexes,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of households	1.00	1.03	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.23	1.25	1.27
Average floor space of new constructions	1.00	0.99	1.05	1.06	1.11	1.10	1.09	1.13	1.14	1.20	1.21	1.22	1.24	1.18	1.19	1.19
Energy intensity (GJ/household)	1.00	0.96	0.97	0.98	0.98	0.95	1.01	0.96	0.86	0.88	0.91	0.86	0.89	0.91	0.88	0.86

* Index: 1990=1.00

FIGURE 3-6: Average Energy Consumption* of New Appliances, 1990 and 2005 Models

Appliance	1990	2005
Clothes washers	1218	444
Clothes dryers	1103	904
Dishwashers	1026	396
Refrigerators	956	469
Electric ranges	772	573
Freezers	714	386

* kWh/yr

FIGURE 3-7: Number of Eligible R-2000 Housing Starts, 1990 to 2006

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Number of R-2000 houses	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	582	478	489

FIGURE 3-8: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000-2007

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2007	Average
Energy use pre-renovation (GJ)	302	228	216	205	200	188	172	216
Actual energy savings after renovations (GJ)	102	66	58	53	47	47	46	60

FIGURE 4.1: Commercial/Institutional Energy Use by Activity Type,* 2005

Activity type	Energy use (petajoules)	Percentage
Offices**	399.5	35
Retail trade	192.1	17
Educational services	158.9	14
Health care and social assistance	105.3	9
Accommodation and food services	86.3	8
Wholesale trade	64.1	6
Transportation and warehousing	54.0	5
Arts, entertainment and recreation	36.3	3
Information and cultural industries	27.6	2
Other services	21.1	2
Total	**1145.2**	**100**

* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 4-2: Commercial/Institutional Energy Use by Purpose,* 2005

End use	Energy use (petajoules)	Percent
Space heating	585.34	51
Auxiliary equipment	165.60	14
Lighting	107.96	9
Space cooling	99.61	9
Water heating	98.58	9
Auxiliary motors	88.06	8
Total	**1145.15**	**1.00**

* Excludes street lighting

FIGURE 4-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.14	1.16	1.20	1.20	1.17	1.22	1.26	1.26	1.34	1.36	1.36	1.42
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35	1.33

* Index: 1990=1.00

FIGURE 4-4: Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2006

Building type	Average energy savings (GJ/year)
Health care	5640
Retail	4215
Education	3700
Retail food sector	3559
Industrial	3302
Other	3301
Multi-unit residential building	3199
Office	2175

FIGURE 5-1: Industrial Energy Use by Subsector – Including Electricity-Related Emissions,* 2005

Subsector	Percent of industrial energy use
Pulp and paper	25.7
Mining	20.2
Other manufacturing	16.8
Petroleum refining	11.2
Smelting and refining	8.2
Iron and steel	7.4
Chemicals	5.8
Cement	2.1
Construction	1.9
Forestry	0.7
Total	**100.0**

* Note: The above subsectors reflect the current definitions in the *Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 5-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005

Industry	Energy cost/ total production cost (%)
Cement	37.07
Aluminum	16.78
Pulp and paper	15.04
Iron and steel	12.99
Chemicals	12.79
Petroleum refining	2.47
Transportation equipment and manufacturing	0.86

FIGURE 5-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements,* 1990 to 2005

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.14	1.14	1.18	1.19	1.24	1.28	1.24	1.28	1.29	1.31	1.31
Actual energy use	1.00	1.08	1.11	1.10	1.08	1.11	1.15	1.10	1.16	1.20	1.20	1.18

* Index: 1990=1.00

FIGURE 5-4: CIPEC Energy Intensity Index,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.91	0.92	0.94	0.91	0.90

* Index: 1990=1.00

FIGURE 5-5: Estimated CIPEC Energy Savings, 2001 to 2006

Energy savings	2001	2002	2003	2004	2005	2006
Program total (petajoules)	1.99	5.10	9.56	14.13	20.16	25.25

FIGURE 5-6: Industrial Dollars to $ense Participants, 1997 to 2006

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Number of industrial workshop participants	98	132	167	260	410	421	490	1001	1051	1303

FIGURE 6-1: Transportation Energy Use by Mode, 2005

Mode of transportation	Energy use (petajoules)	Percentage
Passenger light vehicle	1070.4	42.8
Freight truck	833.0	33.3
Passenger aviation	251.5	10.1
Freight marine	111.2	4.4
Off-road	97.4	3.9
Freight rail	76.4	3.1
Passenger bus	51.8	2.1
Freight aviation	7.9	0.3
Passenger rail	2.5	0.1
Total	**2501.8**	**100.0**

FIGURE 6-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements,* 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.05	1.12	1.15	1.18	1.23	1.27	1.32	1.34	1.36	1.38	1.41	1.48	1.52
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31	1.33

* Index: 1990=1.00

FIGURE 6-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Passenger car (%)	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.7	59.1	60.9	63.0	63.4	62.7	62.1	61.58	61.59
Passenger light truck (%)	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.3	40.9	39.1	37.0	36.6	37.3	37.9	38.42	38.41

FIGURE 6-4: Average Activity per Truck, 1990 to 2005 (tonne kilometres/truck)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium- and heavy-duty truck vehicle activity	105 742	98 658	103 459	117 687	133 653	142 910	141 219	163 975	162 926	175 266	178 269	198 998	197 396	202 326	219 262	236 677

FIGURE 6-5: Trucking Energy Intensity, 1990 to 2005 (megajoules/tonne kilometre)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium- and heavy-duty truck energy intensity	3.71	3.81	3.79	3.62	3.44	3.46	3.41	3.33	3.16	2.99	3.02	2.83	2.80	2.92	2.86	2.72

FIGURE 6-6: Vehicle Fuel Efficiency Labelling

	Percentage of new vehicles with fuel efficiency label affixed	
	On lot	In showroom
1999	64	47
2001	77	56
2005	78	61

FIGURE 6-7: Company Average Fuel Consumption (CAFC) versus Canadian Voluntary Standards, 1990 to 2006*

Truck model year	Truck standard (11.4 L/100 km)	Trucks CAFC (L/100 km)	Car standard (8.6 L/100 km)	Cars CAFC (L/100 km)
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.3	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.8
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.7	8.6	7.5
2005	11.4	10.3	8.6	7.5
2006	11.4	10.6	8.6	7.1

* 2002–2006 data are estimates.

FIGURE 6-8: Drivers Trained, 1998 to 2005*

	Drivers trained
1998	51 000
1999	53 000
2000	112 846
2001	125 000
2002	149 000
2003	160 000
2004	200 000
2005	210 158

* Estimates are based on NRCan internal data.

FIGURE 7-1: Canadian Wind Power Capacity, 1993 to 2006

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wind power capacity (MW)	1	22	23	23	24	27	127	139	215	233	326	445	686	1459

FIGURE 8-1: GHG Emissions Reductions From Federal Operations, 1990 to 2010

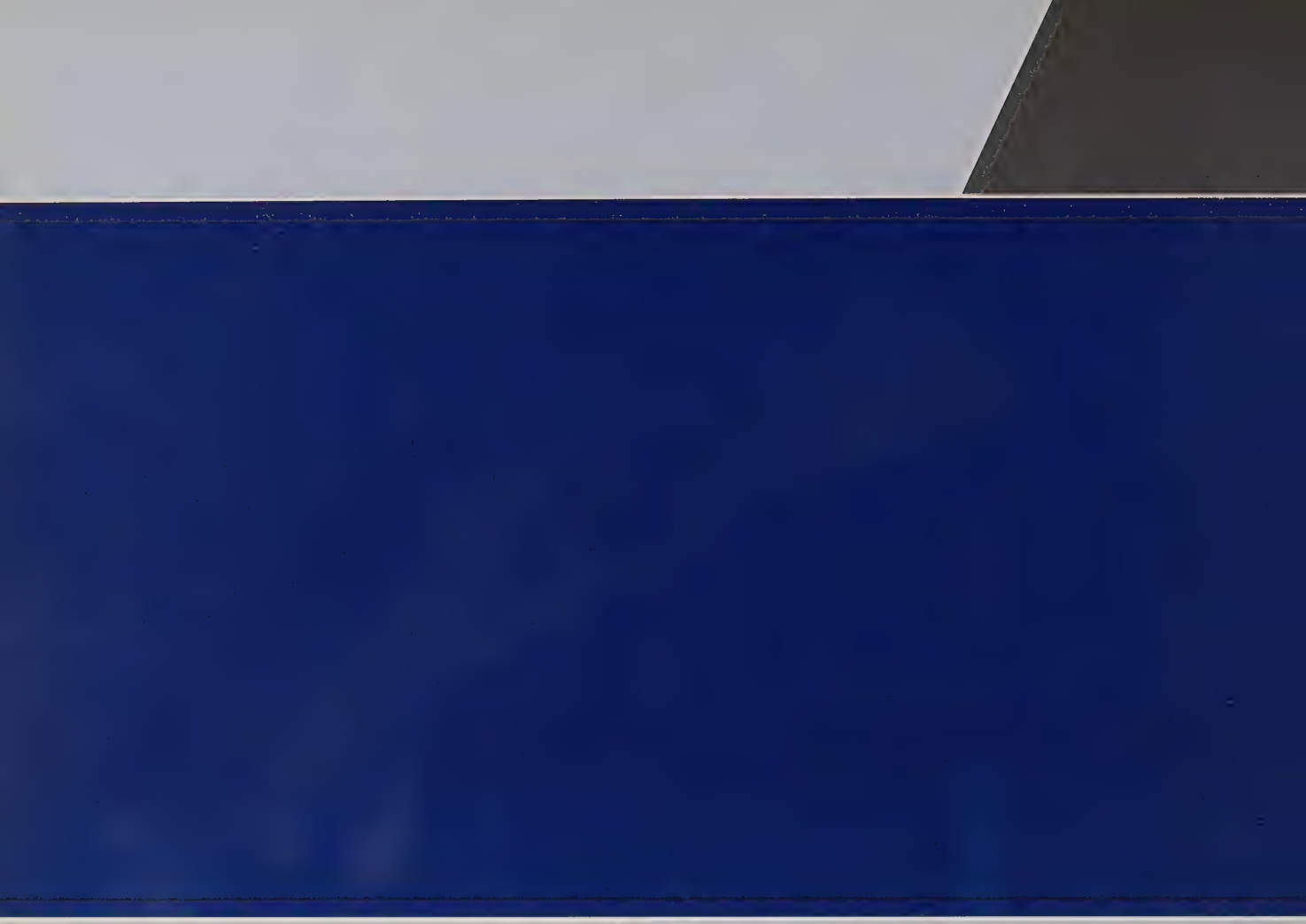
Fiscal year	GHG emissions (kt of CO_2e)
1990	3895
1998	3140
2000	3012
2001	2895
2002	2957
2003	2929
2004	2865
Target 2010	2703

FIGURE 8-2: Federal Fleet Size and Fuel Consumption, 1997 to 2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Vehicles	22 873	22 505	22 558	22 611	24 463	26 233	24 981	25 652	25 968
Litres of gasoline equivalent (thousands)	64 200	63 100	63 100	61 900	66 900	68 619	62 500	64 900	63 800

FIGURE 8-3: Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Vehicles purchased	131	161	181	83	170	521	365	529	591



Natural Resources Canada's Office of Energy Efficiency

Leading Canadians to Energy Efficiency at Home, at Work and on the Road

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Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2007–2008

Canada

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Publishing by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*
pour l'année financière 2007–2008

Cat. no. M141-10/2008E (Print)
ISBN 978-1-100-11432-3

Cat. no. M141-10/2008E-PDF (Online)
ISBN 978-1-100-11433-0

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Minister's Foreword

I am pleased to introduce the 2007/08 Report to Parliament on Natural Resources Canada's energy efficiency and alternative energy programs.

Energy efficiency is the easiest, most affordable and most effective way for families and businesses to control their energy costs and reduce greenhouse gas emissions. During fiscal year 2007/08, our Government strengthened energy efficiency regulations under the *Energy Efficiency Act* (EEA) by giving Canadians new opportunities to control their energy costs and contribute to a healthier environment. We introduced energy performance standards for seven additional products, including light bulbs, and set higher standards for four other products already covered by EEA regulations. As these new regulations come into effect, Canadians can be confident that the products they buy and use every day are among the most energy-efficient in the world.

These new energy-efficiency regulations complement the suite of ecoENERGY programs launched by our Government in 2007. This investment of $3.6 billion is already helping Canadians use energy more efficiently, boost renewable energy supplies and develop cleaner energy technologies.

For example, ecoENERGY Efficiency is helping Canadians make their homes, buildings, industries and vehicles more energy-efficient. ecoENERGY for Renewable Power is encouraging the production of clean electricity for our homes and businesses from renewable sources including wind, biomass, low-impact hydro, geo-thermal, solar photovoltaic and ocean energy. We are pleased that our Government's ecoENERGY Technology initiative is supporting the development of new, cleaner-energy technologies.

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These measures, and others like them, are at the heart of our Government's practical, balanced approach to addressing climate change and reducing air pollution. Our ecoENERGY initiatives have been extremely successful and are continuing to support the efforts of Canadians to reduce emissions. By helping homeowners, businesses and industry make wise energy choices, these initiatives continue to provide both immediate and long-term environmental and economic benefits.

Canadians have made it clear that the health of our environment is a top priority. As the details of this Report to Parliament demonstrate, our Government is responding with real action to address their concerns.

Lisa Raitt

The Honourable Lisa Raitt, P.C., M.P.
Minister of Natural Resources

Executive Summary

Canadians spent approximately $152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

The two general types of energy use are primary and secondary. Primary use represents Canada's total consumption, including energy required to transform one energy form to another – such as coal to electricity – and energy required to deliver energy to consumers. Secondary use is energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2005, the latest year for which figures are available, primary energy use increased by 27 percent.
- In 2005, secondary use accounted for 69 percent of primary energy use and produced 66 percent (495 megatonnes [Mt]) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without the energy efficiency improvements made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumed the most energy, accounting for 38 percent of total secondary energy use in 2005. Transportation was second (29.5 percent), followed by residential (16.5 percent), commercial/institutional (14 percent) and agriculture (2 percent).

Promoting Energy Efficiency

Natural Resources Canada (NRCan) promotes energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan uses a broad range of policy instruments, including leadership, information, voluntary initiatives, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the terms. It is important to understand this difference when comparing Canada with other countries.

Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

Energy intensity is the amount of energy use per unit of activity. Examples of activity measures in this publication are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic product. Energy intensity is a broader measure, capturing not only energy efficiency but also other impacts on energy consumption, such as weather variations, market behaviour and changes in the structure of the economy.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors. However, this growth would have been much greater without improvements in energy efficiency.

As reported in Chapter 1, energy efficiency improvements made between 1990 and 2005 are estimated to have reduced GHG emissions by almost 64 Mt and decreased energy expenditures by $20.1 billion in 2005.

Between 1990 and 2005, the residential sector recorded a 25 percent improvement in energy efficiency. The figures for the transportation (19 percent), industrial (13 percent) and commercial/institutional (9 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce their energy bills and achieve important environmental goals. Over the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

Canada is a world leader in the production of renewable energy, with almost 16 percent of its primary energy supply coming from renewable sources in 2005.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of co-operative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector and highlights NRCan's efficiency and alternative energy (EAE) programs and lists their key achievements for the 2007–2008 fiscal year. Program entries for market transformation programs also include quantitative performance indicators in graph or table format. A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Introduction

NATURAL RESOURCES CANADA'S EFFICIENCY AND ALTERNATIVE ENERGY PROGRAMS

According to the International Energy Agency, if energy efficiency policies had not been introduced 30 years ago, today's worldwide energy consumption would be 50 percent higher.[1]

Gains in energy efficiency have substantial benefits for society, the economy and the environment. Energy efficiency can add to the global security of energy supplies by reducing the need for energy. It saves consumers and businesses money by decreasing their energy bills without disruptions to their daily routine, and it can increase access to energy services by reducing their effective cost.

In particular, greater energy efficiency is used as a strategy to reduce carbon dioxide and other greenhouse gases (GHGs) and thereby help reduce the effects of climate change.

Natural Resources Canada (NRCan) emphasizes the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as ways to reduce GHG emissions and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2007–2008 is in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by the following:

- the Office of Energy Efficiency (OEE), which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- CanmetENERGY and the CANMET Mineral Technology Branch, which deliver EAE research, development and demonstration (R,D&D) initiatives
- the Office of Energy Research and Development, which coordinates NRCan's energy research and development activities
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and co-operation with stakeholders, such as other levels of government, the private sector and nongovernmental organizations.

With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels and in increasing the energy efficiency of energy production.

[1] International Energy Agency, *Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency*, 2007.

POLICY INSTRUMENTS

NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research, development and demonstration

Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations. Regulations primarily establish performance and labelling requirements for energy-using products and for doors and windows that are imported or shipped across provincial borders.

Financial Incentives

NRCan uses financial incentives to encourage end-users of energy to adopt energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants, natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods ranging from broad distribution to individual consultations with clients. This increases awareness of the environmental impact of energy use and encourages consumers to become more energy efficient and make greater use of alternative energy sources. One particular outreach program targets youth as the energy consumers of the future and undertakes joint initiatives in the education sector. Other information activities include publications, exhibits, advertising, toll-free telephone lines, conferences, Web sites, workshops, training, building design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan voluntarily to set and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are major factors in energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, commitments to develop energy efficiency improvement targets and action plans. NRCan provides support to assist and stimulate action by companies and institutions on energy efficiency, including developing standards, educational material and training.

Research, Development and Demonstration

Ongoing improvement in energy efficiency is contingent on improvements and innovations in technology. NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R,D&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking research in its own laboratories and contracting research activities to other organizations. These initiatives are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

FIGURE INT-1

Moving the Market

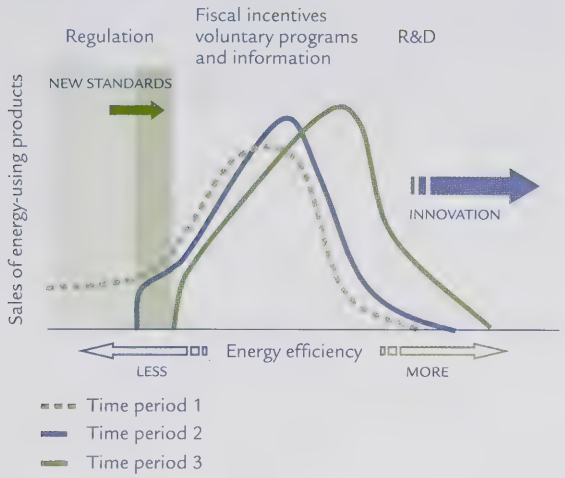


Figure INT-1 shows how these policy instruments work together to increase energy efficiency, i.e. how they help to reduce the amount of energy required to complete a task or obtain a certain level of service. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information activities increase the number of people and organizations taking advantage of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving higher levels of efficiency in a particular type of energy use.

MEASURING PROGRESS

The primary goal of NRCan's EAE initiatives is to change energy consumption patterns and thereby generate environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

NRCan monitors and tracks the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures.

For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and government and non-government programs.

Because program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress toward a market outcome, serves as an indicator of program effectiveness.

An example of a program outcome leading to a market outcome is a householder's purchase of a more energy-efficient appliance, resulting in reduced use of electricity. Depending on what source of electricity is involved and how the utility changes its electricity-generating methods to meet the change in demand resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

DATA COLLECTION AND ANALYSIS

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the Department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support its analytical expertise. The NEUD initiative plays a number of crucial roles directly

related to NRCan program activities. However, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of energy use in the transportation, industrial, commercial/institutional and residential sectors. The surveys gather information about the stocks and characteristics of energy-using equipment and buildings, observing Canadians' behaviour with respect to energy use and monitoring the adoption of new technologies in the marketplace.

In 2007–2008, work was initiated to collect and analyse energy data on the commercial and residential sectors. The data will form the basis for reports explaining how and where energy is used in each of those sectors. Data on the transportation and industrial sectors continue to be collected on a quarterly and annual basis, respectively.

The NEUD initiative also produces a comprehensive energy use database with accompanying publications to explain Canada's overall energy use and energy efficiency trends. All NEUD initiative reports are available to the public, free of charge, both in hard copy and online at oee.nrcan.gc.ca/statistics.

The NEUD initiative also contributes to the development of energy end-use data and analysis centres (DACs) across Canada. Three DACs have been set up so far: the transportation centre at Université Laval in Québec, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta. The DACs are mandated to improve the accessibility and comparability of existing data about trends in energy consumption and their impact on environmental quality.

GHG EMISSIONS AND CLIMATE CHANGE

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of co-operation among all nations.

IN THIS REPORT

This fifteenth annual *Report to Parliament* focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada for the residential, commercial, industrial, transportation and renewable energy sectors are discussed in Chapter 1. Chapter 2 discusses equipment regulations under the *Energy Efficiency Act* and equipment-labelling activities. Chapter 3 describes the suite of ecoENERGY and related programs and lists key 2007–2008 achievements. Chapter 4 explains energy S&T programs, and Chapter 5 outlines NRCan's involvement with renewable energy sources and use. The sixth and final chapter describes domestic and international co-operation in EAE.

Appendix 1 contains information about NRCan's EAE expenditures. Appendix 2 contains detailed information about the figure data presented in this report. Calculations of the estimated GHG savings in this report are based on Environment Canada's standardized emissions factors as described in its publication *Canada's Greenhouse Gas Inventory*. The emissions factor for electricity was based on the provincially weighted average of marginal fuel sources across the country.

CHAPTER 1

Trends in Energy Use

INTRODUCTION

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also fosters the development of industries with a particularly strong energy demand.

Canadians spent about $152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, vehicles and industrial processes. This amount represented 14 percent of the country's gross domestic product (GDP).[2]

ENERGY USE AND GREENHOUSE GAS EMISSIONS

Energy use is of two general types: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use represents the total requirements for all users of energy, including secondary energy use. In Canada, the increase in primary energy use reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 27 percent between 1990 and 2005, from 9740 petajoules[3] (PJ) to 12 369 PJ.

Secondary energy use accounted for 69 percent of primary energy use in 2005, or 8475 PJ. It was responsible for 66 percent (495 megatonnes [Mt]) of total greenhouse gas (GHG) emissions in Canada, including indirect emissions – those produced by electric utilities to meet end-use electrical demand.

From 1990 to 2005, secondary energy use increased by 22 percent. At the same time, the Canadian population grew by 17 percent, and GDP increased 51 percent. Thus energy use grew less rapidly than the economy but more rapidly than the population.

[2] Data in this chapter are presented for 1990–2005. Readers are encouraged to consult the Office of Energy Efficiency Web site to view data updates as they become available.

[3] One petajoule equals 1×10^{15} joules.

As demonstrated in Figure 1-1, the industrial sector was the largest energy user, accounting for 38 percent of total secondary energy use in 2005. The transportation sector was the second largest energy user at 29.5 percent, followed by the residential sector at 16.5 percent, the commercial/institutional sector at 14 percent and the agricultural sector at 2 percent.

FIGURE 1-1

Secondary Energy Use by Sector, 2005

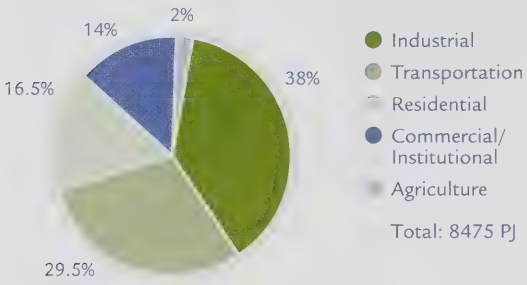
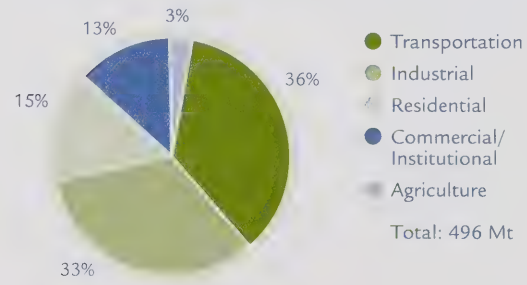


Figure 1-2 illustrates the distribution of GHG emissions by sector. This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 accounts for most of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and emissions that are attributable indirectly to electricity generation, unless otherwise specified.

FIGURE 1-2

GHG Emissions From Secondary Energy Use by Sector, 2005



ENERGY INTENSITY AND ENERGY EFFICIENCY

The term "energy intensity" refers to the amount of energy use per unit of activity. Energy intensity is sometimes used as a proxy for energy efficiency because it is a simple calculation for which data are readily available. However, this measure can be misleading because, in addition to pure energy efficiency, intensity captures the impact of other factors that influence energy demand, such as weather variations and changes in the structure of the economy.

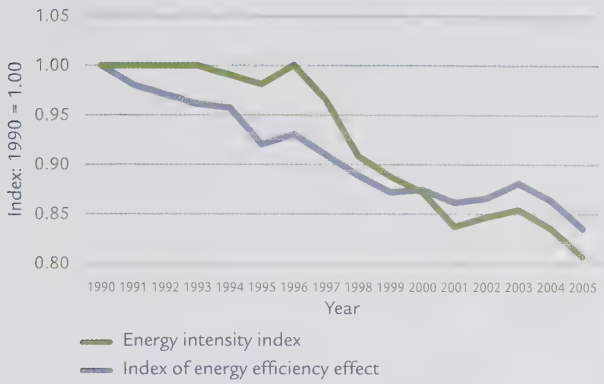
Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique – the Log-Mean Divisia Index I Methodology – to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-3 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over 1990 to 2005. As illustrated, Canada's energy intensity and efficiency improved over this period. The reduction in energy intensity reflects an overall improvement in energy efficiency or how effectively energy is being used in producing one unit of GDP. At the same time, the improvement in energy efficiency indicates how effectively energy is being used to provide a certain level of service or output.

FIGURE 1-3

Energy Intensity and the Energy Efficiency Effect, 1990 to 2005



TRENDS IN ENERGY EFFICIENCY

NRCan regularly publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use and GHG emissions and the contributions of the following key factors to these changes (see Table 1-1):

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- **Service level** refers to the penetration rate of electrical devices and equipment, e.g. the use of auxiliary equipment in commercial/institutional buildings and appliances in homes or the amount of floor space cooled.
- **Energy efficiency** effect indicates how effectively energy is being used, i.e. the degree to which less energy is being used to provide the same level of energy service. Energy efficiency gains occur primarily with improvements in technology or processes. An example of such an improvement would be replacing incandescent lights with compact fluorescent lamps.

TABLE 1-1

Explanation of Changes in Secondary Energy Use, 1990 to 2005

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total*	Change (%)
1990 energy use (PJ)	1286.2	867.0	2721.8	1877.9	6952.1	
2005 energy use (PJ)	1402.2	1153.0	3209.4	2501.8	8475.1	
Change in energy use (PJ)	115.9	286.0	487.6	624.0	1523.0	21.9
Explanatory factor (change due to)						
Activity	353.1	246.6	1166.0	750.4	2516.1	36.2
Weather	5.5	25.2	n/a	n/a	30.8	0.4
Structure	7.1	-1.2	-331.1	186.8	-138.4	-2.0
Service level	71.0	91.8	n/a	n/a	162.9	2.3
Energy efficiency	-320.9	-75.4	-347.3	-352.4	-1096.0	-15.8
Other factors		-1.0		39.2	47.7	0.7

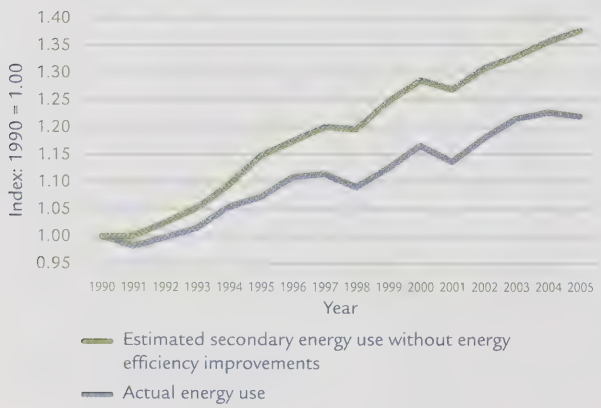
*Total also includes energy use for agriculture.

In this report, changes in energy efficiency are the net result after allowing for changes in energy use due to activity, weather, structure and service level. However, other factors, such as individual consumer choice, may affect energy use and are not captured by the above standardized factors. The effects of activity, weather, structure and service level may overstate or understate the "actual" change in energy use and energy efficiency improvements.

Between 1990 and 2005, secondary energy use in Canada increased from 6952 to 8475 PJ. Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an energy increase of 38 percent. However, as a result of a 16 percent (1096-PJ) improvement in energy efficiency,[4] actual secondary energy use increased by only 22 percent (to 8475 PJ). This improvement in energy efficiency is estimated to have reduced GHG emissions by almost 64 Mt and decreased energy expenditures by $20.1 billion in 2005. The change in energy use between 1990 and 2005, actual and without energy efficiency improvements, is shown in Figure 1-4.

FIGURE 1-4

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



TRENDS IN RENEWABLE ENERGY

Canada is a leader in the production of renewable energy, with 16 percent of its primary energy supply coming from renewable sources in 2006. Although renewable energy is often associated with electricity, renewable energy sources also produce thermal energy (heat) and transportation fuels. Renewable energy sources in Canada include water, wind, solar, geothermal and biomass.

Canada has a significant renewable electricity supply due primarily to the widespread use of hydroelectricity. In 2005, about 60 percent of Canada's electricity generation was provided by conventional and small hydroelectric plants, which generated more than 358 terawatt hours (TWh) of electricity, up from 337 TWh in 2004. Small hydro plants (less than 50 megawatts [MW]), with installed generating capacity of 3421 MW, provided about 2 percent of the total electricity generation in Canada.

Non-hydro renewable sources accounted for an estimated 2 percent of Canada's total electricity generation. Biomass (waste and virgin biomass and landfill gas) is the main non-hydro renewable energy source in Canada. However, wind energy is growing rapidly, with an increase in capacity from 139 MW in 2000 to 1459 MW in 2006. Solar photovoltaic energy also experienced high rates of capacity growth – about 20 percent annually between 1993 and 2006 – although it started from a low baseline. In 2006, 20.5 MW of solar photovoltaic systems were installed in Canada, representing an increase of 3.7 MW over the previous year.

As described in Chapter 5, NRCan is carrying out two initiatives, ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat, to increase the use of small-scale renewable energy in Canada.

[4] Based on the OEE Index.

TRENDS IN RESIDENTIAL SECTOR

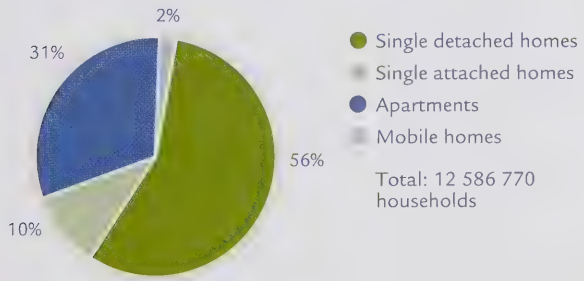
Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling; water heating; and the operation of appliances, electronic equipment and lights. In 2005, this sector accounted for 17 percent (1402 PJ) of secondary energy use and 15 percent (73.8 Mt) of GHGs emitted in Canada.

Most dwellings in Canada are single detached houses. The next largest type of dwelling is apartments, followed by single attached dwellings and mobile homes (see Figure 1-5). The OEE's ecoENERGY Retrofit – Homes and ecoENERGY for Buildings and Houses programs aim to improve the energy efficiency of single detached and attached houses.

FIGURE 1-5

Canadian Households by Type of Dwelling, 2005



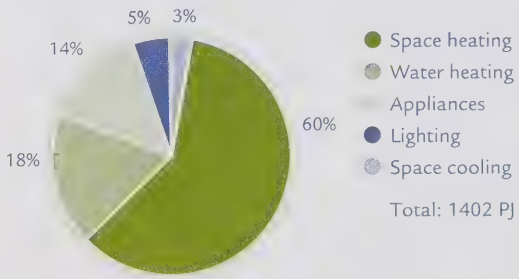
Between 1990 and 2005, residential energy use increased by 9 percent, or 116 PJ. For the same period, GHG emissions increased by 6 percent. GHG intensity decreased 14 percent despite the average household operating more appliances, becoming larger and increasing its use of space cooling. Space and water heating constituted 78 percent of residential energy use, followed by operating appliances, lighting and space cooling (see Figure 1-6).

Five main factors influenced residential energy use between 1990 and 2005 – activity, weather, structure, service level and energy efficiency effect:

- Activity – The increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 28 percent (353 PJ).
- Weather – The winter in 2005 was similar to the winter in 1990 but summer temperatures were much warmer, and the result was a 0.4 percent (5.5-PJ) increase in energy use in 2005.
- Structure – The relative share of households by dwelling type (single detached, apartments, etc.) changed over the period. This change contributed to an increase in energy use of 0.6 percent (7 PJ) in 2005.
- Service level – The increased market penetration rate of appliances and increased floor space cooled by space-cooling units increased energy use by 6 percent (71 PJ).
- Energy efficiency effect – Improvements to the thermal envelope of houses and to the efficiency of residential appliances and space- and water-heating equipment led to an overall gain in energy efficiency and decreased energy use by 25 percent (321 PJ).

FIGURE 1-6

Residential Energy Use by End-Use, 2005

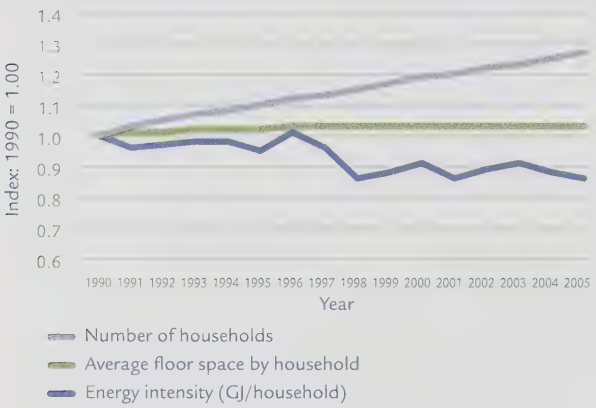


Growth in residential energy use was driven in large part by growth in activity. This growth in activity – specifically, growth in total floor space and number of households – was due to the increase in the average size of newly constructed houses, the rising population and the trend toward fewer individuals per household (see Figure 1-7).

These increases were partially offset by significant improvements in energy efficiency. Structural changes also contributed to growth in energy use, because more individuals tended to live in single detached homes and the relative share of individuals living in apartments declined. Similarly, service level increased energy demand, because more Canadians cooled their homes during the summer months in 2005 than in 1990 and Canadians operated more appliances in 2005 than they did in 1990.

FIGURE 1-7

Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2005



Energy Efficiency

The change in residential energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency measures are shown in Figure 1-8. Overall energy efficiency upgrades – including improvements to the thermal envelope (insulations, windows, etc.) and more energy-efficient appliances, furnaces and lighting – resulted in significant monetary savings for each Canadian household. The 25 percent improvement in energy efficiency between 1990 and 2005 translated into $6.1 billion in energy savings in 2005. Figure 1-9 shows how energy consumption differs for houses built in different periods, reflecting improvements in building construction. Figure 1-10 shows how average energy consumption of new appliances has improved, by comparing 1990 and 2005 models.

FIGURE 1-8

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

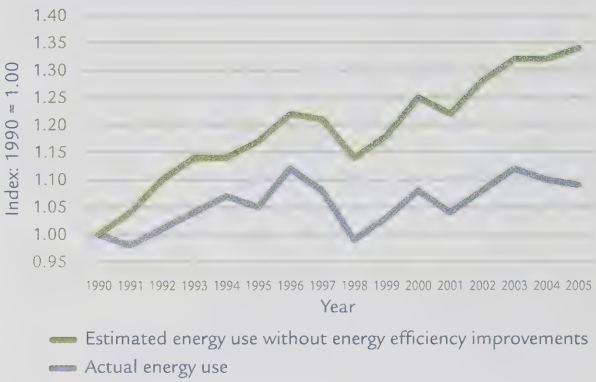
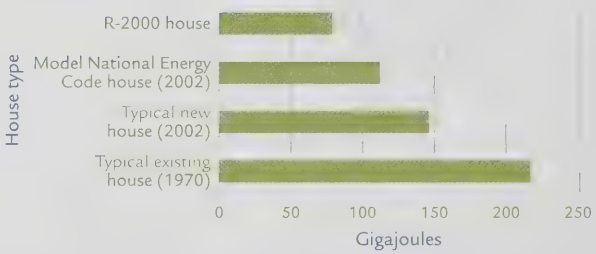


FIGURE 1-9

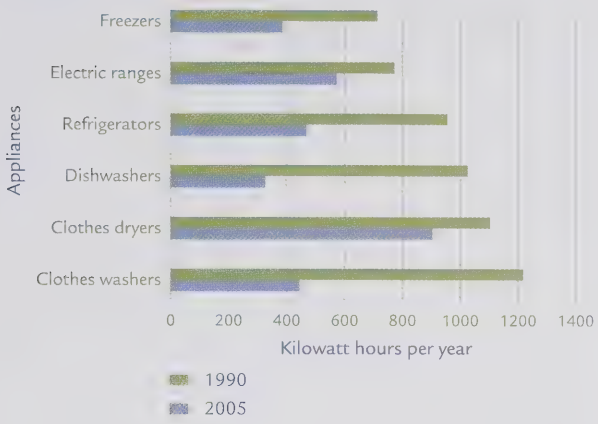
Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 1-10

Average Energy Consumption of New Electric Appliances, 1990 and 2005 Models



NRCan carries out the following initiatives to increase energy efficiency in the residential sector:

- ecoENERGY Retrofit – Homes
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN COMMERCIAL/ INSTITUTIONAL SECTOR

Energy Use and Greenhouse Gas Emissions

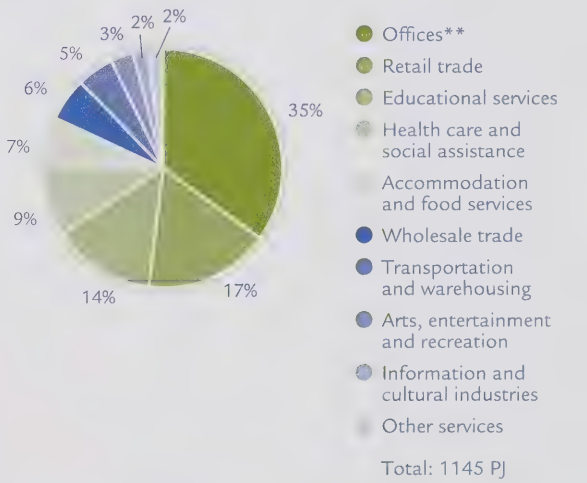
The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, operation of auxiliary equipment, space cooling, lighting, motive power for such services as pumping and ventilation in buildings, and street lighting.

In 2005, the commercial/institutional sector accounted for 14 percent (1153 PJ) of secondary energy use and 13 percent (65.3 Mt) of GHG emissions in Canada. Between 1990 and 2005, commercial/institutional energy use (including street lighting) increased by 33 percent, or 286 PJ. However, GHG emissions from the sector rose by 37 percent in the same period. The increase in use of GHG-intensive fuels, such as heavy oil and light fuel oil, explains why GHG emissions grew at a faster pace than energy use.

To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 1-11). In 2005, offices accounted for 35 percent of the sector's energy demand. Retail trade, educational services, health care and social assistance, and accommodation and food services accounted for another 47 percent of that demand. NRCan initiatives address all major activity types.

FIGURE 1-11

Commercial/Institutional Energy Use by Activity Type*, 2005



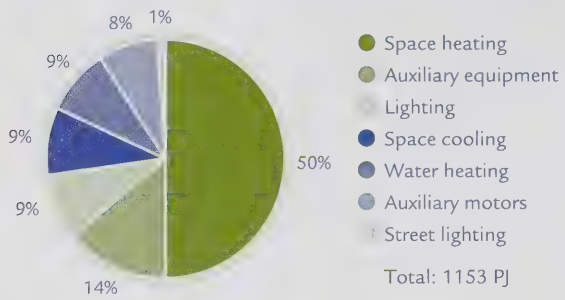
* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

Energy is used for six purposes in commercial/institutional activities. As illustrated in Figure 1-12, in 2005, the largest of these was space heating, which accounted for more than half of energy use in the sector. Five of the remaining six uses of energy accounted for between 8 and 14 percent of energy demand in the sector.

FIGURE 1-12

Commercial/Institutional Energy Use by Purpose, 2005



Five main factors influenced commercial/institutional energy use between 1990 and 2005 – activity, weather, structure, service level and energy efficiency effect:

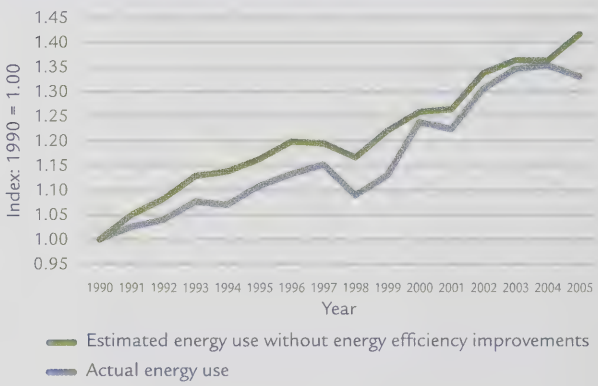
- Activity – More floor space increased energy use in the sector by 28 percent and caused a 247-PJ increase in energy use.
- Weather – The winter of 2005 was similar to the winter of 1990, but the summer was warmer than in 1990. The net result was a 3 percent increase in energy use (25 PJ) for space cooling.
- Structure – The impact of structural changes (mix of building types) was marginal but produced a decrease of 1 PJ in energy use.
- Service level – An increase in the service level of auxiliary equipment (e.g. computers, photocopiers) and space cooling caused an 11 percent increase in energy use (92 PJ).
- Energy efficiency effect – A 9 percent improvement in energy efficiency saved 75 PJ of energy.

Energy Efficiency

Gains in energy efficiency were made through improvements to the thermal envelope of buildings (insulation, windows, etc.) and increased efficiency of energy-consuming items, such as furnaces, auxiliary equipment and lighting, which slowed down the rate of increase in energy use. Without improvements in energy efficiency, energy use in the commercial/institutional sector would have increased by 41 percent. However, between 1990 and 2005, actual energy use increased by only 32 percent, resulting in energy savings of $1.6 billion in 2005. The change in energy use between 1990 and 2005, as well as the estimated energy savings due to improvements energy efficiency, are shown in Figure 1-13.

FIGURE 1-13

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



NRCan carries out the following initiatives to increase energy efficiency in the commercial/institutional sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (See Chapter 2)

TRENDS IN INDUSTRIAL SECTOR

Energy Use and Greenhouse Gas Emissions

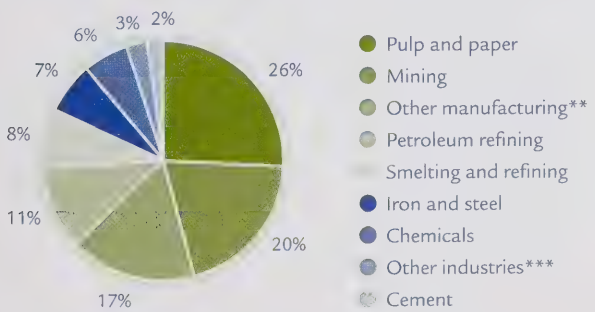
The industrial sector includes all manufacturing industries, all mining activities (including oil and gas extraction), forestry and construction. However, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power and to produce heat or generate steam.

Overall, industrial energy demand in 2005 accounted for 38 percent (3209 PJ) of secondary energy use and 33 percent (164 Mt) of GHG emissions (including electricity-related emissions). Between 1990 and 2005, actual industrial energy use increased by 18 percent (488 PJ). This increase was caused by a 44 percent increase in industrial activity, measured as a combination of physical units of production, gross output and GDP.

In the industrial sector, energy was consumed primarily in pulp and paper production, mining, petroleum refining, and in the smelting and refining industries. Pulp and paper production alone accounted for approximately 26 percent of total industrial energy demand in 2005 (see Figure 1-14).

FIGURE 1-14

Industrial Energy Use by Subsector – Including Electricity-Related Emissions*, 2005



*The above subsectors reflect the current definitions in the *Report on Energy Supply-demand in Canada*.

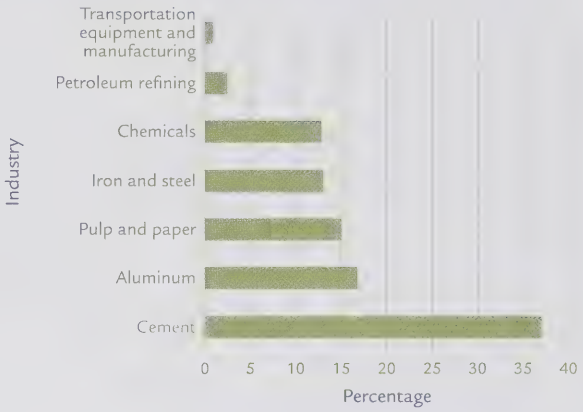
**"Other manufacturing" comprises more than 20 manufacturing industries.

***"Other industries" includes construction and forestry.

In most industries, energy purchases accounted for only a small portion of total expenditures. However, for some relatively energy-intensive industries – cement, aluminium, pulp and paper, iron and steel, and chemicals – this share was higher than 12 percent (see Figure 1-15). For cement, in particular, the share was as high as 37 percent.

FIGURE 1-15

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005



Between 1990 and 2005, industrial GHG emissions, including electricity-related emissions, increased by 16 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 8 percent. Most of this increase in direct GHG emissions occurred in the upstream oil and gas industry. The mining, manufacturing and construction industries, however, achieved a 9 percent decrease in GHG emissions.

Three main factors influenced industrial energy use between 1990 and 2005 – activity, structure and energy efficiency effect:

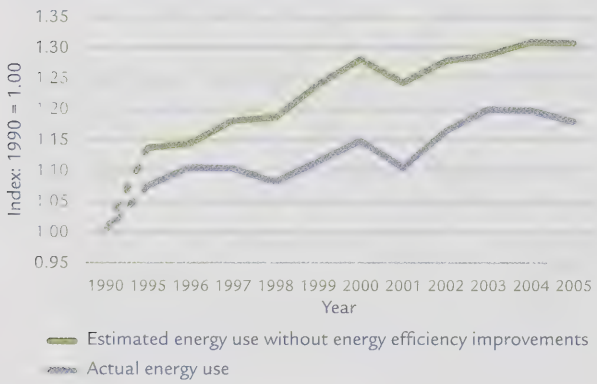
- Activity – Increases in the physical units of production, gross output and GDP contributed to a 43 percent increase in industrial activity, resulting in a 1166-PJ increase in energy use.
- Structure – The shift in the mix of activity toward less energy-intensive industries caused a 331-PJ decrease in energy use.
- Energy efficiency effect – Owing to a 13 percent improvement in energy efficiency, the industrial sector avoided 347 PJ of energy use.

Energy Efficiency

The change in energy use between 1990 and 2005 and the estimated energy savings attributed to energy efficiency are shown in Figure 1-16.

FIGURE 1-16

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



Energy efficiency improvements in the form of more efficient capital and management practices are important factors in managing energy use and decreasing energy intensity. Between 1990 and 2005, energy efficiency in the industrial sector improved 13 percent. In 2005, Canadian industry saved $3.9 billion in energy costs. This gain was largely the result of improvements in energy intensity, representing the shift toward less energy-intensive activities. However, the energy savings from the energy efficiency improvements made by some industries were offset by increases in consumption by the upstream oil and gas, fertilizer and forestry subsectors.

NRCan carries out the following initiatives to increase energy efficiency in the industrial sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Industry
- Clean Energy Systems for Industry
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN TRANSPORTATION

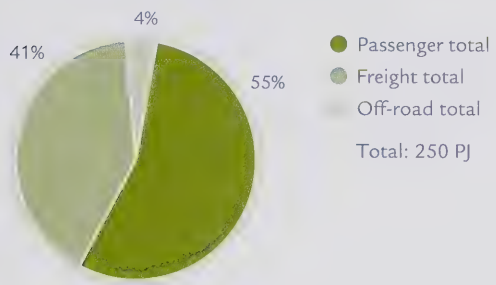
Energy Use and Greenhouse Gas Emissions

In 2005, transportation was second to the industrial sector in terms of energy use, accounting for 30 percent (2502 PJ) of Canada's total secondary energy use and the largest portion of Canadian end-use GHG emissions at 36 percent (177.5 Mt). Transportation accounts for a greater share of GHG emissions because the main fuels used by the sector are more GHG-intensive than those used in other sectors of the economy.

The transportation sector consists of three subsectors: passenger, freight and off-road. In 2005, passenger and freight transportation accounted for 55 percent and 41 percent of transportation energy use respectively, while off-road represented only 4 percent (see Figure 1-17). Owing to limitations in the available data and the small percentage it accounts for, the off-road subsector is not analysed in further detail.

FIGURE 1-17

Transportation Energy Use by Mode, 2005



The passenger subsector has three modes: road, rail and air. The freight subsector, as defined by NRCan, is composed of road, rail, air and marine modes. Within these two subsectors, road transport uses the most energy, accounting for 78 percent of total transportation energy use in 2005.

All of NRCan's transportation energy use programs focus on the energy used in road transportation. Total transportation energy use increased by 33 percent (624 PJ) between 1990 and 2005. Within the transportation sector, passenger transportation energy use increased by 16 percent (188 PJ), while freight transportation energy use increased by 61 percent (391 PJ).

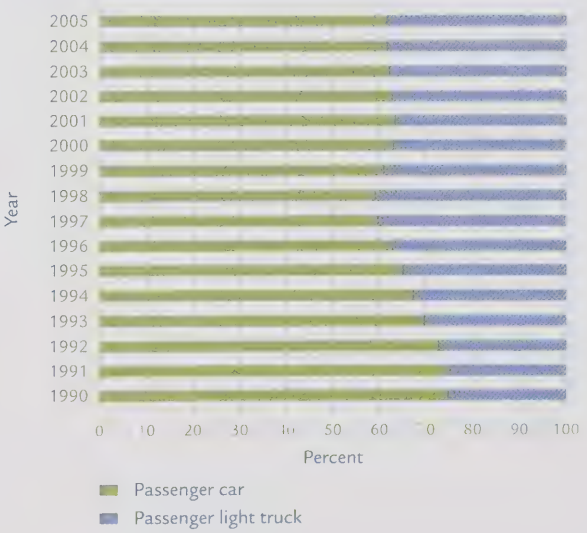
Three main factors influenced transportation energy use between 1990 and 2005 – activity, structure, and energy efficiency effect:

- Activity – Increases in population, air transportation and economic activity (e.g. free trade) caused increased transportation activity.[5] The change in activity increased transportation energy use by 40 percent (750 PJ). Contributing to this increase were the freight and passenger segments, which increased by 52 and 48 percent respectively.
- Structure – Shifts between modes of transport within both the freight and passenger segments caused an increase of 10 percent in transportation energy use (187 PJ). Specifically, an increase in international trade and customer requirements for just-in-time delivery and the popularity of minivans and sport utility vehicles (SUVs) contributed to a rise in energy use.
- Energy efficiency effect – Improvements in the energy efficiency of passenger and freight transport decreased energy use by 19 percent (352 PJ).

Figure 1-18 shows how the market share of new light trucks increased in the 1990s, reflecting the increase in popularity of minivans and SUVs. Recently, however, this trend seems to have stabilized, with the share of light trucks remaining steady over the past few years. The higher share of heavier and more powerful passenger vehicles has had a significant effect on the increase in passenger energy use.

FIGURE 1-18

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005



[5] Measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation.

Energy Efficiency

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 50 percent. However, between 1990 and 2005, actual energy use increased by only 33 percent. During this period, energy efficiency in the transportation sector improved by 19 percent, leading to a savings of $8.5 billion in 2005. This change in energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency improvements are shown in Figure 1-19.

FIGURE 1-19

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

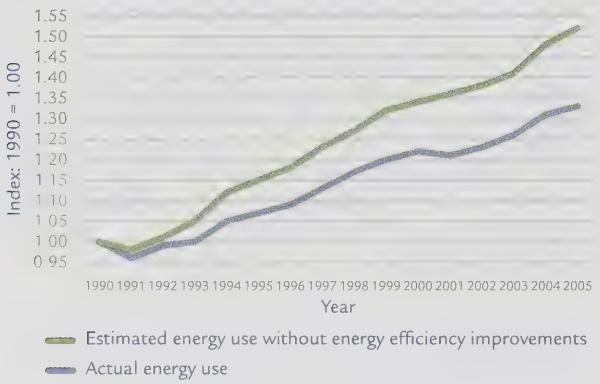
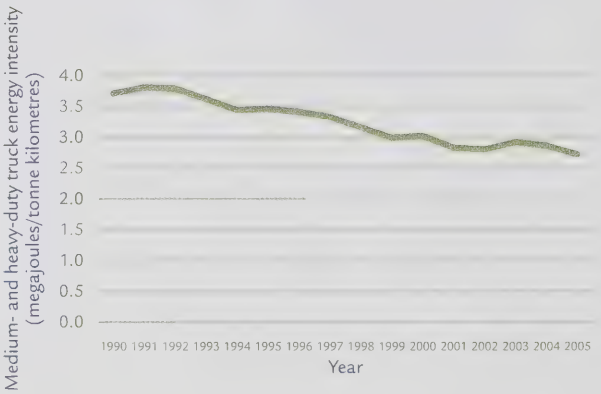


FIGURE 1-20

Average Activity per Truck, 1990 to 2005

FIGURE 1-21

Trucking Energy Intensity, 1990 to 2005



Figures 1-20 and 1-21 illustrate an improvement in trucking energy intensity despite an increase in average activity from 1990 to 2005. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have improved fuel efficiency in medium- and heavy-duty trucks.

NRCan carries out the following initiatives to increase the efficiency of motor vehicle use:

- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- Clean Transportation Energy

TRENDS IN ALTERNATIVE AND RENEWABLE FUELS

Alternative and Renewable Fuels

Alternative fuels are fuels used for transportation other than petroleum-based gasoline and diesel. Some alternative transportation fuels, such as ethanol and biodiesel, are renewable; others, such as propane and natural gas, are non-renewable. Other possible alternative transportation fuels include next-generation biofuels, coal-to-liquids, electricity and hydrogen.

"Renewable fuel" is a broad term covering a range of fuels made from renewable energy sources that are naturally replenished in a relatively short period. The sources include biomass, hydropower, geothermal energy, wind energy and solar energy.

Biofuels is a well-known category of renewable fuel and can be produced from a variety of sources. Two commercially available biofuels are ethanol and biodiesel. Conventional ethanol is produced from sugars or starches, and biodiesel production typically uses vegetable oils and animal fats. In Canada, ethanol is typically produced from corn and wheat, while canola oil, soy oil and tallow are relevant biodiesel feedstocks.

Gasoline vehicles manufactured since the 1980s can use up to 10 percent ethanol in gasoline, and many diesel vehicle manufacturers include the use of 5 percent or higher biodiesel blends. Under development are next-generation biofuels, such as cellulosic ethanol. These biofuels could be made from non-conventional sources, such as agricultural residues, forest residues and waste materials.

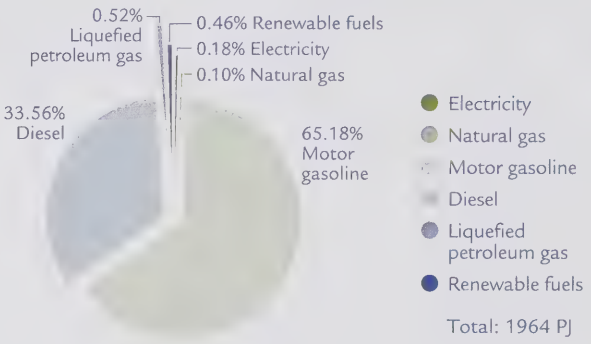
Renewable Fuels Production

Renewable fuels production in Canada has increased since the emergence of ethanol in Manitoba in the 1980s. Between 2000 and 2006, domestic renewable fuel production capacity increased by more than 200 percent, from 207 million litres to 656 million litres annually. For 2008, ethanol production is estimated to be 1.3 billion litres.

In 2005, renewable fuels used in the transportation sector represented less than 0.5 percent of fuel used, as shown in Figure 1-22. The renewable fuel consumed was predominately ethanol blended with gasoline in lower-level ethanol blends.

FIGURE 1-22

Shares of On-Road Transportation Fuel, 2005



The federal regulation being developed will require an average annual renewable fuel content of at least 5 percent based on the volume of the gasoline pool, commencing in 2010, and at least 2 percent renewable content in the distillate pool by 2012.

NRCan carries out initiatives to increase the use and production of renewable and alternative fuels under the following programs:

- ecoENERGY for Biofuels
- Ethanol Expansion Program
- Sustainable Development Technology Canada's NextGen Biofuels Fund™

CHAPTER 2

Equipment Standards and Labelling

INTRODUCTION

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes standards and labelling programs that are based on the requirements of Canada's *Energy Efficiency Regulations* (the Regulations).

The *Energy Efficiency Act* of 1992 gives the Government of Canada the authority to make and enforce regulations that prescribe standards and labelling requirements for energy-using products that are imported to Canada or shipped across provincial borders for lease or sale. The *Energy Efficiency Regulations* came into effect in February 1995, after extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. Since then, the Regulations have been amended a number of times.

The performance standards contained in the Regulations and accompanying labelling requirements and programs make a major contribution to the government's Clean Air Regulatory Agenda (CARA). Regulations have now been established for more than 30 products that consume 71 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector.

Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors, commercial refrigeration and some lighting products. The Regulations apply to these products even if they are incorporated in a larger unit or machine that is not regulated. As announced by the Government of Canada in October 2006, the Regulations will be amended to prescribe standards for 20 new products and increase the stringency of existing standards for 10 products by 2010.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products when the market has achieved a higher level of efficiency. The Regulations are also amended to add new products, harmonize minimum energy performance requirements with those of other jurisdictions and update testing methodologies and labelling requirements. In addition, regulations can be established for gathering market data on the energy performance of certain types of equipment. For example, the data gathered for gas fireplaces is used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before amending the Regulations, NRCan conducts studies to determine how the proposed change will affect the market. A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and the Regulations, as well as on their practical application in the marketplace.

The Act and the Regulations also support labelling initiatives. These are designed to help consumers and the commercial/industrial procurement community identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas (GHG) emissions over the life of the product.

The Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners. For appliances, the EnerGuide label shows the estimated annual energy consumption of the product in kilowatt hours and compares it with the most and least efficient models of the same class and size. The EnerGuide label for room air conditioners indicates the model's energy efficiency ratio and provides a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product is published on the back page of the manufacturer's brochure. These ratings include the annual fuel utilization efficiency rating for oil and gas furnaces, the fireplace efficiency rating for gas fireplaces and the seasonal energy efficiency ratio for central air conditioners.

The ENERGY STAR® Initiative in Canada works with and complements the Regulations and comparative EnerGuide label. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy-efficient on the market. Products that are prescribed in the Regulations and are also part of the Initiative must meet levels of energy efficiency significantly above the minimum performance levels set out in the Regulations to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, their efficiency levels trigger the development of new minimum energy performance standards.

STANDARDS

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world. This practice minimizes the regulatory burden on manufacturers and avoids confusion for consumers.

For example, the performance requirements in the Regulations are similar to those in several Canadian provinces that regulate energy-using equipment manufactured and sold within their borders. This similarity is achieved because governments support and participate in the development of national, consensus-based performance standards by accredited standards-writing organizations, such as the Canadian Standards Association.

Such standards include testing procedures that are used to determine a product's energy performance and are usually referenced federally and provincially. NRCan works closely with provinces throughout the regulatory process to ensure that the federal and provincial standards regimes are harmonized to the maximum extent possible. Because the North American market is highly integrated, Canada's energy performance requirements for many products are similar to regulations in the United States.

Canada is an active participant in international and regional forums, such as the Asia-Pacific Economic Cooperation Energy Working Group, the North American Energy Working Group and the Asia-Pacific Partnership on Clean Development and Climate, which are important for regional co-operation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of these working groups.

NRCan supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission. It also supports the national and international policy work of the Standards Council of Canada.

COMPLIANCE AND ENFORCEMENT

The Regulations outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use enforcement measures when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the Act prescribes specific enforcement measures when dealers violate the law. Enforcement activities include preventing the importation of non-compliant products to Canada, preventing the sale or lease of non-compliant products in Canada and imposing fines. Violators can also be fined under the Administrative Monetary Penalty System of the Canada Border Services Agency for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information from energy efficiency reports and import documents. Section 5 of the Act requires dealers to provide energy efficiency reports when they market a new product model. The required information includes the energy performance of each model, the name of the testing agency and the size category, as described in Schedule IV of the Regulations.

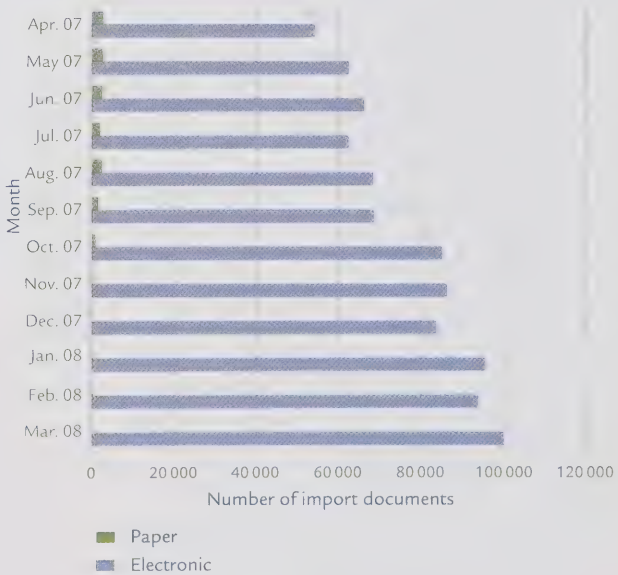
The Regulations require that, when importing a regulated product into Canada, dealers provide specific product information on customs documents for all shipments (i.e. type of product, brand name, model number, name and address of dealer and purpose of import). A customs document contains less information than an energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan can then confirm that all products entering Canada meet the required energy performance levels and can take action when necessary.

NRCan processed more than 942 441 records (records from April 1, 2007, to March 31, 2008) relating to the importation of regulated energy-using products to Canada in 2007–2008. Figure 2-1 illustrates the volume of import documents received in paper form and electronically per month during the 2007–2008 fiscal year.

More than 855 093 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2007, to March 31, 2008) from dealers' energy efficiency reports.

FIGURE 2-1

Volume of Monthly Import Documents



REGULATORY IMPACT TO DATE FROM THE REGULATORY IMPACT ANALYSIS STATEMENT

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette, Part II*.

It is estimated that Canada's energy performance standards will cause a reduction of 25.6 megatonnes (Mt) in aggregate annual emissions by 2010 (see Table 2-1).

TABLE 2-1

Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)

Product (amendment number in brackets)	Energy savings (PJ)		CO_2 reductions (Mt)	
	2010	2020	2010	2020
Residential appliances (1)	117.20	133.84	13.26	15.60
Lamps – fluorescent/incandescent (2)	11.60	13.40	7.55	9.80
Motors (3)	16.30	17.70	2.03	2.14
Commercial HVAC (4)	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49*	1.10*
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39*	0.94*
Clothes washers, domestic water heaters, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (9)	1.57	5.35	0.16	0.53
Total	**178.15**	**240.86**	**25.60**	**34.29**

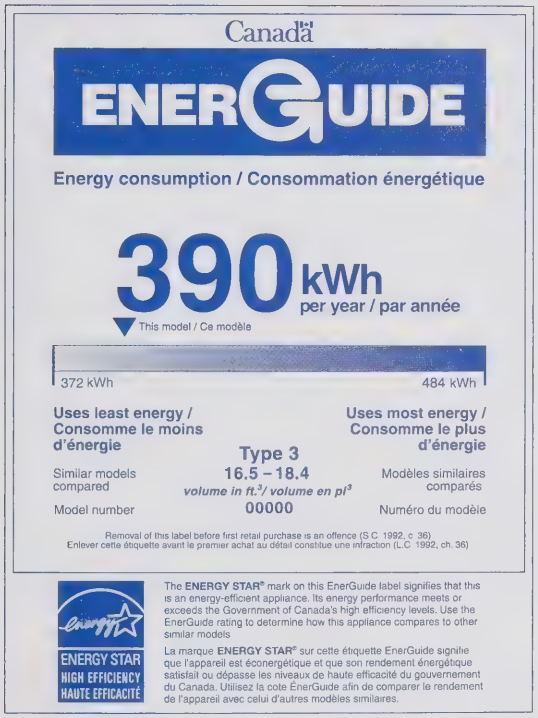
*Values are different from Regulatory Impact Analysis Statement due to a change in the emission factor to 99.3.

LABELLING AND PROMOTION

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of appliances. In 1995, with the introduction of the Regulations, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. The label on a product shows how much energy a product uses, allowing the customer to consider the most energy-efficient choice.

FIGURE 2-2

EnerGuide Label



EnerGuide directories that list energy ratings for major appliances and room air conditioners are published annually. They are distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. Online directories for all appliances and heating and cooling equipment are published on the Web site of the Office of Energy Efficiency (OEE) and updated monthly.

A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, gas fireplaces were added to the EnerGuide rating program, and manufacturers were asked to include EnerGuide ratings for fireplace efficiency in their brochures. These changes coincided with the mandatory requirement in the Regulations to test, verify and report on fireplace efficiency.

Major distributors of these products for sale in Canada report the verified energy performance rating of their products, as tested against the standards in the Regulations. In addition, participants in the voluntary EnerGuide rating program must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that can result from labelling.

Given that the equipment products listed above are typically purchased from a brochure or catalogue, a consumer would probably not read the EnerGuide label before making a decision to buy. Accordingly, manufacturers are encouraged to include an EnerGuide rating in product brochures and catalogues, so consumers can compare the efficiency of products when they are in the buying process. To date, manufacturers of 85 percent of eligible products on the market voluntarily participate in the EnerGuide rating program and publish the ratings in their brochures.

Regularly conducted polls indicate that more than 50 percent of Canadians surveyed are aware of the EnerGuide label.

In 2001, responding to public interest in a labelling system that identifies the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). Canada signed an agreement with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The OEE is the custodian of the program for Canada. Canada joins other international ENERGY STAR program participants: Australia, New Zealand, Japan and Taiwan, and the European Union, which adopted ENERGY STAR for office equipment.

FIGURE 2-3

ENERGY STAR® Label

ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected on the basis of their technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the eligibility criteria and performance levels. For appliances and heating and cooling products, the criteria are based on the same test standards as those applied under the Regulations. Canada promotes specific product categories for which levels and criteria can be harmonized with those of the United States, including the following:

- major electrical appliances
- heating, cooling and ventilation
- consumer electronics
- office equipment
- windows, doors and skylights (Canadian levels)
- selected lighting products – compact fluorescent lamps (CFLs), fixtures, decorative light systems and solid-state lighting
- selected commercial equipment, including commercial refrigeration products

Canada has also integrated ENERGY STAR with the EnerGuide label for qualified major appliances and room air conditioners, to help consumers identify the best-performing products. While the EnerGuide label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. Now that industry-accepted standards of high efficiency have been established, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

ENERGY STAR is used as the basis for incentives by many electrical and gas utilities across Canada. For example, Hydro-Québec promotes ENERGY STAR qualified refrigerators and CFLs as part of its *Mieux Consommer* program and provides incentives for these product categories. Kitchener Utilities, Enbridge Gas and Terasen Gas develop point-of-sale and incentive programs around ENERGY STAR qualified gas-fired heating systems.

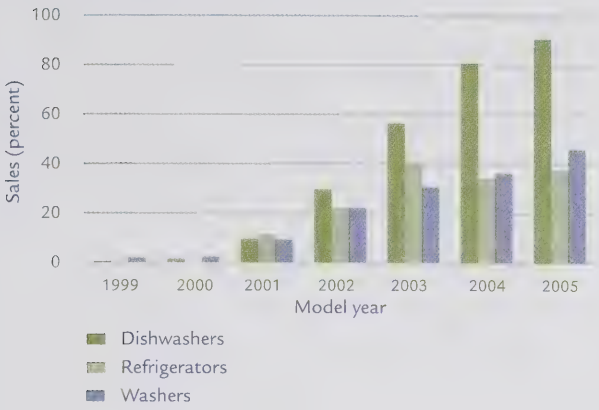
ENERGY STAR is also the qualifying criterion for sales tax exemptions in British Columbia for heating and cooling equipment; in Saskatchewan for the purchase of furnaces, boilers and qualifying appliances (refrigerators, dishwashers, clothes washers and freezers); and in Ontario. Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher efficiency products.

Continuous promotion of ENERGY STAR qualified appliances has paid off. Industry statistics for 2005 show an increase in market penetration from almost nil in 2000 to 38 percent for refrigerators and 91 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and manufacturers' willingness to raise the efficiency of their products to qualifying levels.

ENERGY STAR specifications and levels are periodically updated as product saturation is reached, to encourage industry to strive for more efficient products and thus maintain the relevance and credibility of the brand.

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005



ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to vending machines. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and to address barriers to their widespread acceptance.

Canada continues to promote ENERGY STAR guidelines in its contacts with the procurement community. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. Workshops were held across Canada to make governments and institutions aware of the ENERGY STAR criteria and procurement tools.

Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products for replacement equipment.

Canada continues to expand the range of product types included in its ENERGY STAR agreement. Canada led the way in the development of a technical specification for decorative light strings (also known as Christmas lights) and implemented this specification for Canada. In addition, Canada recently included fixtures, solid state lighting and external power supplies in its agreement with the Government of the United States. Finally, Canada is developing an ENERGY STAR specification for heat recovery ventilators.

NRCan developed a rating and labelling system for efficient refrigeration applications in ice and curling rinks under the name CoolSolution.[6] An ice rink application is qualified CoolSolution if it achieves a rating higher than 50 percent. An incentive program to encourage the adoption of CoolSolution and reduce the initial payback of the first applications started in November 2006. Partnerships to accelerate the program have been successful.

CoolSolution designates innovative technologies and practices and consists of three main elements:

- heat recovery from the refrigeration system to meet all the building's heating requirements (e.g. hot air, hot water) or to export this energy for other purposes.
- adaptation to the Canadian climate by taking advantage of the naturally occurring cold temperatures. This is done by varying the temperature of the heat released into the environment according to the outdoor temperature.
- reduction of the synthetic refrigerant charges of the refrigeration system, which have a serious adverse impact on climate change. This is done by using natural refrigerants or by confining the synthetic refrigerant to the mechanical room and using environmentally friendly fluids to remove and distribute heat.

[6] CoolSolution is an official mark of Her Majesty the Queen in the Right of Canada as represented by the Minister of Natural Resources.

ecoENERGY FOR EQUIPMENT

Objective

To exclude the least efficient energy-using equipment from the market and to influence consumers to select – and manufacturers to produce – energy-efficient products that perform above minimum standards.

Description

The ecoENERGY for Equipment program is focused on accelerating the introduction of energy-efficient products in Canada's equipment stock. The program implements minimum energy efficiency performance standards that restrict the importation and interprovincial/interterritorial shipment of the least efficient products for sale in Canada. It also carries out initiatives to increase the market share of more efficient products.

ecoENERGY for Equipment also supports labelling programs that encourage the introduction of more efficient technologies. This involves the establishment and promotion of high-efficiency performance criteria, such as ENERGY STAR, and the engagement of stakeholders to promote products that meet these criteria. As products are adopted in the marketplace, the ENERGY STAR or equivalent performance level will become the basis for new, more stringent standards.

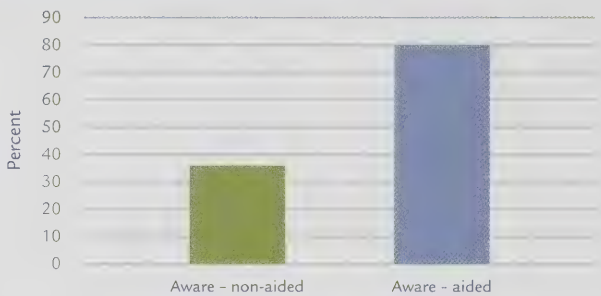
In addition, ecoENERGY for Equipment maintains a multilayered compliance and enforcement program to ensure that products meet prescribed standards and to ensure that other regulatory requirements, such as labelling, are met.

Program components include the following:

- regulations under the *Energy Efficiency Act* requiring dealers to ship only products that meet the prescribed energy efficiency standards
- the EnerGuide program, which rates and labels the energy efficiency of major household electrical appliances and heating, ventilating and air-conditioning equipment, assisting consumers in making energy-wise purchases
- the ENERGY STAR high efficiency program, which is an international initiative that identifies the most energy-efficient products in their class (see Figure 2-5)

FIGURE 2-5

ENERGY STAR Awareness Levels in Canada, 2005



Targets

Estimates indicate that by 2011, this program will result in energy savings of between 13.4 and 14.9 petajoules. At present, these energy savings convert to annual emissions reductions of between 1.4 and 1.6 Mt of GHGs and related Criteria Air Contaminants emissions.

Key 2007–2008 Achievements

- Undertook a complete analysis of options to amend the *Energy Efficiency Act* for expansion and strengthening of product regulations and provided recommendations to policy and decision-makers.
- Conducted the analysis of, and consultations necessary to pre-publish, Amendment 10 to the *Energy Efficiency Regulations*. This amendment proposes to increase the stringency of existing standards for four products; introduce standards for an additional seven products, including light bulbs; and introduce labelling requirement for a number of other lighting products.
- Conducted primary research into the standby power consumption of a myriad of products sold in Canada to provide the analytical basis for proposed standards limiting standby power consumption.
- Delivered four specialized workshops on ENERGY STAR to the procurement and institutional community.
- Maintained a comprehensive database of ENERGY STAR qualified products and information that assist utilities and other organizations across Canada in their energy efficiency programs (rebates, incentives and tax exemptions).
- Participated in a collaborative effort with the Mont-Mégantic Observatory, Hydro-Québec and Québec communities to reduce "fugitive" outdoor lighting and thereby reduce energy consumption and ensure the continued effectiveness of the Observatory.
- Coordinated the development of multi-stakeholder communities of interest with the objective of defining long-term strategic end-use objectives for lighting, space conditioning, service water use and standby power consumption. These forums will establish a framework for meeting those objectives and monitor progress toward achieving them.

For more information:

oee.nrcan.gc.ca/corporate/programs.cfm

CHAPTER 3

Energy Efficiency and Alternative Transportation Fuels

Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) aims to strengthen and expand Canada's commitment to energy efficiency in all sectors and increase the production and use of alternative transportation fuels in Canada. The OEE is the manager of the ecoENERGY Efficiency Initiative, under the ecoENERGY suite of programs initiated on April 1, 2007. The ecoENERGY Efficiency Initiative includes the following programs:

- ecoENERGY Retrofit
- ecoENERGY for Buildings and Houses
- ecoENERGY for Industry
- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- ecoENERGY for Biofuels
- ecoENERGY for Equipment (see Chapter 2)

In addition to ecoENERGY, the OEE manages the Ethanol Expansion Program and the Federal Buildings Initiative.

This chapter describes the objective of each of the aforementioned programs and outlines key achievements for the 2007–2008 fiscal year.

ecoENERGY RETROFIT

Objective

To provide incentives for energy efficiency improvements in homes and in small and medium-sized organizations in the institutional, commercial and industrial sectors. The program is made up of three components:

- ecoENERGY Retrofit – Homes
- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY Retrofit – Existing Buildings Initiative

Targets

Estimates indicate that by 2011, ecoENERGY Retrofit as a whole will result in energy savings between 12.78 and 14.20 petajoules (PJ). At present, these energy savings convert to annual emissions reductions of between 1.0 and 1.1 megatonnes (Mt) of greenhouse gases (GHGs) and related Criteria Air Contaminants (CAC) emissions.

For more information:

ecoaction.gc.ca/retrofit

ecoENERGY RETROFIT – HOMES

Objective

To assist homeowners and owners of existing low-rise properties make smart energy retrofit decisions that will result in significant energy savings and a cleaner environment.

Description

Property owners can qualify for federal grants by improving the energy efficiency of their homes and reducing their home's impact on the environment. ecoENERGY Retrofit – Homes offers a professional evaluation by a qualified energy advisor of the energy efficiency characteristics of a house, including a diagnostic test to determine air leakage.

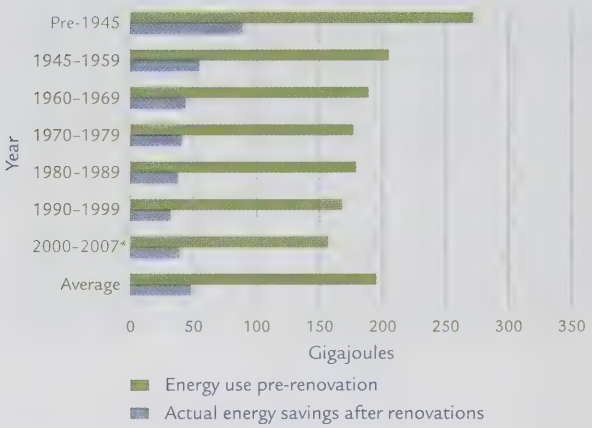
The energy advisor prepares a detailed personalized checklist of recommended upgrades for the property owner, including the EnerGuide pre-retrofit energy rating of the house. The checklist shows the recommended, most effective upgrades. The property owner chooses which upgrades to have done.

After the retrofit work is complete, the advisor performs a post-retrofit energy evaluation and assigns a new energy-rating label. After the required improvements have been made, the property owner is entitled to a grant.

It is expected that the ecoENERGY Retrofit – Homes incentives will promote smart energy use in more than 140 000 homes and will yield an average 30 percent reduction in energy use and costs. Figure 3-1 illustrates the energy use and savings gained per household before and after renovations.

FIGURE 3-1

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007



*Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

Key 2007–2008 Achievements

- Over 102 000 homeowners have applied for a pre-retrofit assessment.
- Over 12 000 homeowners have completed their retrofits and have received grants.
- Established collaborative agreements with provinces, territories, utilities and other stakeholders, including British Columbia, the City of Edmonton, Saskatchewan, Manitoba, Ontario, Hydro-Québec, the Agence de l'efficacité énergétique du Québec, Gaz Métro, Gazifère, New Brunswick, Nova Scotia, Yukon and the Northwest Territories.

ecoENERGY RETROFIT – SMALL AND MEDIUM ORGANIZATIONS

Objective

To encourage Canadian businesses to make their commercial and institutional buildings and industries more energy efficient.

Description

ecoENERGY Retrofit – Small and Medium Organizations provides incentives to businesses to incorporate energy-efficient features in building improvement projects and the upgrading of industrial equipment and processes. Industrial facilities with fewer than 500 employees and commercial and institutional buildings of less than 10 000 square metres may be eligible for funds through contribution agreements with ecoENERGY Retrofit – Small and Medium Organizations.

ecoENERGY Retrofit will provide up to 25 percent of the cost of a project, to a maximum of $50,000. Recipients of funding in this category may also qualify for funding support from utilities and/or other levels of government. To qualify, eligible organizations must submit an application detailing the energy efficiency project, including the total budget, timeframe for completion and expected results, based on a certified technical assessment of the organization's energy use.

Key 2007–2008 Achievements

- Nine information sessions were held with 435 participants.
- Ninety-six small and medium organizations had their planned retrofit projects approved for assistance.

ecoENERGY RETROFIT – EXISTING BUILDINGS INITIATIVE

Objective

To encourage commercial businesses and public institutions to become more energy efficient and reduce GHG emissions.

Description

The ecoENERGY Retrofit – Existing Buildings Initiative (EBI) was wound down during the 2007–2008 fiscal year. While active, it helped commercial organizations and public institutions explore energy efficiency options and strategies. The program provided access to tools and financial assistance to help reduce energy costs and improve competitiveness. It enrolled more than 2800 commercial, institutional, and multiunit residential organizations as members and provided over $72 million in federal incentives.

Key 2007–2008 Achievements

- The EBI signed 95 contribution agreements for retrofit projects and 28 contribution agreements for planning activities.
- Projects that received financial incentives under the EBI are expected to result in average energy savings of approximately 20 percent.

FEDERAL BUILDINGS INITIATIVE

Objective

To assist Government of Canada organizations in implementing energy efficiency upgrades that lead to reduced energy and water use, GHG emissions and operating costs.

Description

The Federal Buildings Initiative (FBI) is an energy efficiency program targeting federal departments and agencies and Crown corporations. The FBI provides a range of products and services required by an organization in order to implement comprehensive energy efficiency improvement projects in its facilities.

The products include case studies, workshops, technical information, model procurement documents and a qualified list of private-sector energy management firms that can provide energy performance contracting services. FBI services include facilitation such as energy management technical advice, program policy advice and procurement services to assist organizations in making energy efficiency improvements.

Other levels of government, institutions and private sector firms also draw on the FBI's experience for help in designing their own energy efficiency programs. Through the FBI, thousands of federal buildings have been upgraded, saving millions of dollars and reducing the risks associated with climate change.

Key 2007–2008 Achievements

- The Canadian Forces bases in Gander, Newfoundland and Labrador, and Gagetown, New Brunswick, are proceeding with energy efficiency retrofit projects that are expected to save $5 million in annual energy costs.
- To date, the private sector has made new and incremental investments of $319 million in FBI projects.
- The FBI awarded energy efficiency projects that will reduce the federal government's annual utility bills by $43 million.

For more information:

oee.nrcan.gc.ca/communities-government/buildings/federal/federal-buildings-initiative.cfm

ecoENERGY FOR BUILDINGS AND HOUSES

Objective

To encourage the construction and operation of more energy-efficient buildings and houses using complementary activities, such as rating, labelling and training. This four-year program was launched April 1, 2007.

Description

The ecoENERGY for Buildings and Houses program includes the following activities for the buildings sector:

- implementing new design tools and training, such as the Dollars to $ense workshop, so designers, builders, owners and operators can learn about and use best practices and new technologies for energy-efficient buildings
- updating building energy ratings and promoting labelling systems for housing, including the EnerGuide Rating System, R-2000,[7] ENERGY STAR® and Built Green™, to encourage consumers to invest in energy-efficient options (see Figure 3-2)
- engaging in ongoing dialogue and co-operation with provincial and territorial programs with a view to encouraging other levels of government to adopt more stringent building energy codes
- providing training and implementing outreach and communication strategies to increase awareness and build capacity among building owners, managers and consumers to support the adoption of sustainable energy efficiency programs.

[7] R-2000 is an official mark of Natural Resources Canada.

- establishing and maintaining partnerships to reduce energy use and improve energy efficiency information

FIGURE 3-2

Number of Eligible R-2000 Housing Starts, 1990 to 2007

Targets

Estimates indicate that by 2011, this program will result in energy savings of between 17.09 and 18.99 PJ. At present, these energy savings convert to annual emissions reductions of 1.3 and 1.4 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Held 207 workshops and trained over 4296 professionals in energy-efficient construction systems for the housing and buildings sectors.
- Issued 108 661 housing labels for new and existing houses.
- Completed a memorandum of understanding (MOU) with the National Research Council to collaborate on the forthcoming update of the *Model National Energy Code for Buildings*.

For more information:

ecoaction.gc.ca/ecoenergy-ecoenergie/buildingshouses-batimentshabitations-eng.cfm

ecoENERGY FOR INDUSTRY

Objective

To improve industrial energy intensity and reduce energy-related industrial GHGs and air pollution.

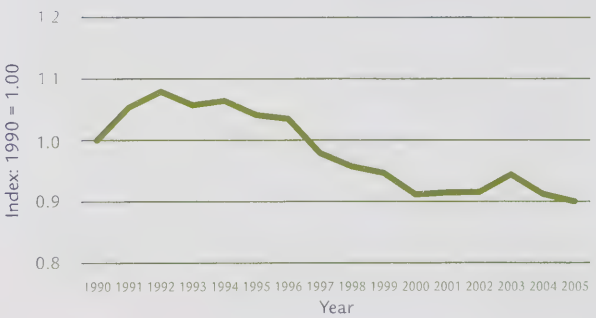
Description

The ecoENERGY for Industry program promotes an increase in energy-saving investments across Canada's industrial sector. The program helps industry become more energy efficient by providing it with tools and services for overcoming the technical, management and financial barriers to project implementation.

ecoENERGY for Industry is an industry-government partnership delivered through the Canadian Industry Program for Energy Conservation (CIPEC). CIPEC is committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial subsectors. The estimated CIPEC energy intensity index is shown in Figure 3-3.

FIGURE 3-3

CIPEC Energy Intensity Index, 1990 to 2005



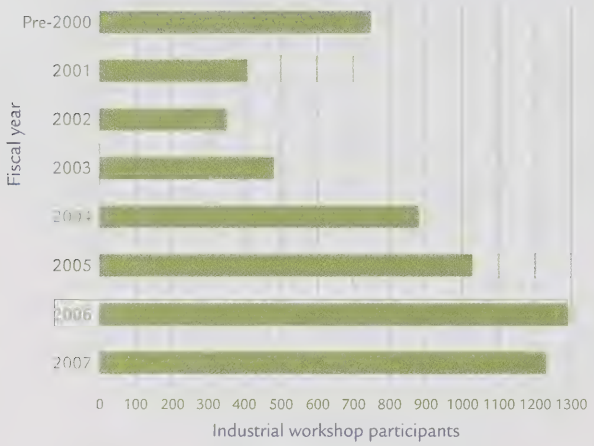
Program components include the following:

- the Dollars to $ense energy management workshops, which teach industry members how to improve operational efficiency, create a better work environment and reduce GHG emissions (see Figure 3-4)

- the ecoENERGY Assessment Incentive for Industry, which offers a financial incentive to help industrial companies conduct state-of-the-art process integration and computational fluid dynamics studies that identify opportunities for increasing energy efficiency and improving production processes
- the CIPEC Leaders network, which demonstrates the industrial sector's commitment to reducing energy use, gives members recognition, networking opportunities for best-practice sharing and eligibility for financial incentives

FIGURE 3-4

Industrial Dollars to $ense Participants, pre-2000 to 2007



Targets

Estimates indicate that by 2011, this program will result in energy savings of between 4 and 17 PJ. At present, these energy savings convert to annual emissions reductions of between 0.4 and 1.7 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Delivered Dollars to $ense energy management workshops for 1290 industrial participants.
- Initiated six studies on process integration, computational fluid dynamics, combustion and energy performance contracting.
- Welcomed 156 new members to the CIPEC Leaders network, which has over 1600 members, and held 59 network meetings.

For more information:

ecoaction.gc.ca/ecoenergy-ecoenergie/industry-industrie-eng.cfm

ecoENERGY FOR PERSONAL VEHICLES

Objective

To encourage and support improvements in energy efficiency by encouraging Canadians to buy, drive and maintain their vehicles with fuel efficiency in mind.

Description

The ecoENERGY for Personal Vehicles program raises awareness of the impact of vehicle choice and use on fuel efficiency and the environment. It does so through the following:

- decision-making information and tools, such as the *Fuel Consumption Guide*, labels and vehicle awards
- "Eco" driver education and training
- idle-free and tire inflation campaigns
- collaborative ventures with community groups and industry stakeholders

ecoENERGY for Personal Vehicles also facilitates work with the vehicle industry to implement and monitor the voluntary MOU between the Government of Canada and the auto industry to reduce automobile GHG emissions. Program components include the following:

- the EnerGuide labelling system, which places fuel consumption labels on all new light-duty vehicles sold in Canada (see Figure 3-5)

- the 2005 MOU between the Government of Canada and the Canadian auto industry, which provides a framework for auto makers to produce more fuel-efficient and lower-GHG-emission vehicles by 2010 (see Figure 3-6)
- the annual ecoENERGY for Vehicles Awards, which recognize, and identify for consumers, the most fuel-efficient light-duty vehicles in their classes sold in Canada
- the Auto$mart driver education series, which teaches drivers how to drive safely, save money and protect the environment by using fuel-efficient driving techniques
- idle-free and tire maintenance campaigns, which, through the use of educational materials and outreach activities, encourage drivers to embrace fuel-efficient practices

FIGURE 3-5

New Vehicle Fuel Efficiency Labelling

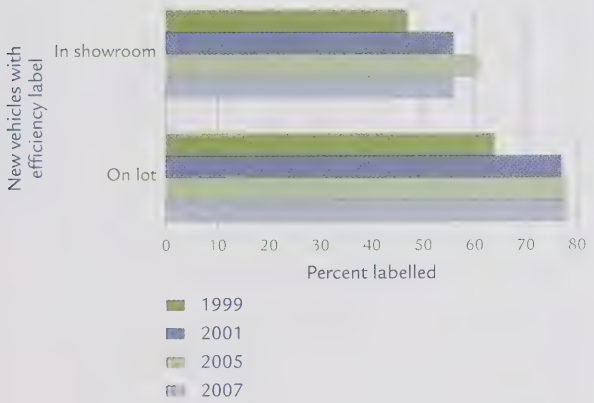
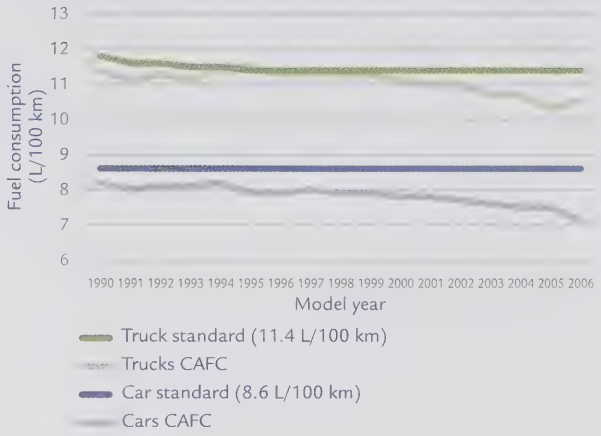


FIGURE 3-6

Company Average Fuel Consumption (CAFC) Versus Canadian Voluntary Standards, 1990 to 2006*



* 2002–2006 data are estimates.

Targets

Estimates indicate that by 2011, this program will result in energy savings of between 50.5 and 75.2 PJ. At present, these energy savings convert to annual emissions reductions of between 4.8 and 5.4 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Distributed over 350 000 copies of the *Fuel Consumption Guide*, including 186 000 to 3386 new car dealerships and 53 000 to Canadian Automobile Association offices.
- Trained 350 000 drivers in fuel-efficient driving practices.
- Reached over 5 million Canadians through exhibits and other marketing activities.

For more information:

vehicles.gc.ca

ecoENERGY FOR FLEETS

Objective

To achieve reductions in fuel use and related costs, air contaminants and GHG emissions through a wide range of measures targeting operators and managers of Canada's commercial and institutional road vehicle fleets.

Description

The ecoENERGY for Fleets program promotes the adoption of existing and emerging new technologies, such as energy-efficient vehicle components and hybrid technologies, and best practices, such as fuel management techniques, in the commercial/institutional road transportation sector.

ecoENERGY for Fleets is aimed at the commercial/institutional fleet transportation sector and provides information, workshops, technical demonstrations and training programs on fuel-efficient practices for fleet vehicles. Program components include the following:

- the "Idle-Free Quiet Zone" campaign, which uses educational materials and incentives to encourage truck drivers to turn off their vehicles at truck stops
- Fuel Management 101 workshops, which assist fleet managers with the preparation, implementation and monitoring of a fuel management plan
- SmartDriver training programs, which offer knowledge sharing and on-the-road instruction to drivers of various types of fleets for the purpose of reducing fuel consumption

Targets

Estimates indicate that by 2011, this program will result in energy savings of between 6.87 and 10.84 PJ. At present, these energy savings convert to annual emissions reductions of between 0.5 and 0.7 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Registered 62 truck stops across Canada under the "Idle-Free Quiet Zone" campaign.
- Developed new bilingual materials for Fuel Management 101 workshops and conducted four workshops.
- Trained 423 school bus drivers under the SmartDriver for School Bus program.

For more information:

fleetsmart.gc.ca

ECOENERGY FOR BIOFUELS

Objective

To encourage the development of a competitive domestic industry for the production of renewable alternatives to gasoline and diesel in Canada.

Description

ecoENERGY for Biofuels will invest up to $1.5 billion over nine years to support the production of renewable alternatives to gasoline and diesel in Canada. Announced in 2007, the initiative will make investment in production facilities more attractive by partially offsetting the risks associated with fluctuating feedstock and fuel prices. The program will provide an operating incentive to producers of renewable alternatives to gasoline, such as ethanol, and renewable alternatives to diesel, such as biodiesel, in cases where they have signed a contribution agreement with NRCan and where industry needs support to remain profitable.

ecoENERGY for Biofuels is a key component of Canada's renewable fuels strategy, which aims to

- reduce the GHG emissions resulting from fuel use
- encourage greater production of biofuels
- accelerate the commercialization of new biofuel technologies
- provide new market opportunities for agricultural producers and rural communities

Key 2007–2008 Achievements

- Program received required approvals.
- Consultations were conducted with biofuels industry stakeholders on program design to ensure program effectiveness.
- Program roll-out was completed, including Web materials, application form and contribution agreement template.

For more information:

ecoaction.gc.ca/biofuels

ETHANOL EXPANSION PROGRAM

Objective

To expand fuel ethanol production and use in Canada and reduce transportation GHG emissions.

Description

The Ethanol Expansion Program (EEP) was a $100-million program, co-managed by NRCan and Agriculture and Agri-Food Canada, for which funding ended March 31, 2007. The program provided contributions, with repayment terms, toward the construction costs of new ethanol production facilities or the expansion of existing ones. The intermediate outcomes of the EEP are expanded ethanol production, increased consumer adoption of ethanol and more markets for ethanol fuels in Canada. Nine ethanol plant projects were allocated contributions under the EEP. The longer-term outcome is a reduction in GHG emissions from the transportation sector as ethanol replaces conventional fuels.

Key 2007–2008 Achievements

- Four new ethanol plants started production, adding approximately 313 million litres of ethanol to Canada's annual ethanol production capacity and bringing the total annual capacity to 871 million litres per year.
- Construction started on two other ethanol plants, which will add another 350 million litres per year in 2008.
- These six plants, which were allocated a total of $63.7 million under the EEP, will reduce GHGs on a full life-cycle basis by an estimated 0.9 Mt a year.

For more information:

vehiclefuels.gc.ca

CHAPTER 4

Energy Science and Technology

INTRODUCTION

Natural Resources Canada (NRCan) invests in the research, development and demonstration (R,D&D) of new and emerging energy science and technology (S&T) that produces economic, social and environmental benefits for Canadians. NRCan's Office of Energy Research and Development (OERD) and CanmetENERGY lead the federal government's energy S&T operations.

The OERD oversees the management of the Program of Energy Research and Development (PERD) and Technology and Innovation Research and Development (T&I R&D). These programs allocated over $84 million in 2007–2008 to help find new, long-term, cleaner and more efficient solutions to reducing environmental emissions by developing and disseminating new knowledge and new technologies through R,D&D initiatives. The OERD is also implementing the $230-million ecoENERGY Technology Initiative announced in mid-2007. About 75 percent of the programs and activities allocated funding by the OERD are managed and carried out by the Department (including CanmetENERGY).

CanmetENERGY generates and provides knowledge and technologies to advance the development and use of innovative solutions contributing to the well-being of Canadians and to progress toward meeting Canada's economic, social and environmental policy objectives. It works with industry, academia, utilities, associations, nongovernmental organizations and other governments to develop and demonstrate energy-efficient, alternative and renewable energy technologies and processes. It undertakes projects and activities in the following areas of expertise:

- clean energy systems for buildings and communities
- clean electric power generation
- clean energy systems for industry
- clean transportation energy
- environmentally sustainable oil and gas development
- bioenergy

This chapter describes in detail the programs, activities and 2007–2008 key achievements of the OERD, CanmetENERGY and other partners in energy S&T.

PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT

Objective

To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

Description

PERD's budget for 2007–2008 was approximately $56.6 million. NRCan allocated $42.6 million to energy R&D programs managed and carried out in the Department, more than 50 percent of which contributed to improved energy efficiency and the integration of renewable energy sources in Canada. The remaining $13 million was allocated to 12 federal departments and agencies that are PERD partners.

Efficiencies are sought in energy production, distribution and end-use. Production encompasses fossil fuels and alternative sources, including biomass. Examples of funded projects are outlined in the remainder of this chapter.

During 2007–2008, based on recommendations of an advisory panel and as mandated in the 2005 Budget, the management of energy S&T delivery was reorganized into a streamlined set of portfolios encompassing the whole innovation chain, from basic research to applied research, pilot plants and demonstrations, thereby ensuring faster market access to technologies developed with federal funds.

For more information:

nrcan.gc.ca/eneene/science/perdprde-eng.php

TECHNOLOGY AND INNOVATION RESEARCH AND DEVELOPMENT

Objective

To advance promising greenhouse gas (GHG) reduction technologies through R&D, promote demonstration and early adoption initiatives to achieve long-term GHG reductions, and strengthen Canada's technology capacity.

Implemented in 2003 with $115 million in federal funding over five years, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to 2025. R&D is conducted in the strategic areas of advanced end-use efficiency technologies in buildings, transportation, industry, decentralized energy production (including renewables), biotechnology, the hydrogen economy, and cleaner fossil fuels (e.g. searching for efficiencies in bitumen and heavy oil, unconventional gas supply, and clean coal and carbon capture). An expenditure review reduced funding to $109 million.

The T&I R&D budget for 2007–2008 was $28 million. NRCan allocated $20.7 million to energy R&D programs managed and carried out in the department. Key NRCan R&D achievements contributing to improved energy efficiency in Canada are included in the programs described in this chapter. The remaining $7.3 million was allocated to seven federal departments that are T&I R&D partners.

A result achieved through investment in renewable energy over many years (through PERD and T&I R&D funding) prompted Iogen Corporation, an Ottawa producer of industrial enzymes, to build the first commercial plant in Canada to convert waste biomass like straw into cellulosic ethanol fuel. Using waste biomass feedstocks has the potential for life-cycle GHG emissions reductions of 80 percent compared with gasoline, and biomass feedstocks offer the added advantage of costing less than grain. NRCan estimates that ethanol produced with Iogen's technology could generate GHG reductions about twice as large as the amounts achievable with conventional grain-based ethanol.

ecoENERGY TECHNOLOGY INITIATIVE

The ecoENERGY Technology Initiative is a $230-million federal government investment in S&T to accelerate the development and market readiness of clean energy technology solutions. The Initiative is a component of ecoACTION, the suite of government actions targeting clean air and GHG emissions reductions. It will help in the search for long-term solutions to reduce and eliminate air pollutants from energy production and use. The Initiative aims at eight high-priority technology areas, is based on extensive consultation with stakeholder groups and promotes public-private collaboration.

Energy Technology Priority Areas

The Initiative is directed toward increasing clean energy supplies, reducing energy waste and reducing pollution from conventional energy. In this context, its eight priority technology areas are as follows:

- cleaner fossil fuels – focusing on the environmental aspects of oil sands development
- clean coal and carbon capture and storage
- distributed electricity generation from renewable energy and other clean energy sources
- next-generation nuclear energy technologies
- bio-based energy systems
- low-emissions industrial systems
- clean transportation systems
- built environment – focusing on the integration of renewable energy technologies in buildings and community systems

NRCan identified these priorities by consulting stakeholders, including the National Advisory Panel on Sustainable Energy Science and Technology, the Energy Technology Working Group of the Council of Energy Ministers, the National Round Table on the Environment and the Economy, and the Canadian Academy of Engineering.

The ecoENERGY Technology Initiative focuses heavily on private-public collaborative arrangements. The Initiative will be delivered primarily through the following:

- responses to NRCan calls for competitive, theme-based project proposals from the national energy S&T community
- federal laboratories, to continue and establish clean energy research in the eight priority areas of the Initiative

CLEAN ENERGY SYSTEMS FOR BUILDINGS AND COMMUNITIES

Objectives

To develop, demonstrate and promote – in domestic and foreign markets – technologies, practical decision-making tools, processes, codes, standards and best practices that help communities select more efficient and cost-effective energy, waste and water technologies and design solutions to support a sustainable energy future based on reduced energy consumption and GHG emissions.

Description

CanmetENERGY plays a leadership role in the R,D&D of energy-efficient and renewable energy technologies for houses, buildings and communities by

- fostering the commercialization of new technologies
- identifying and developing opportunities for integration of technologies
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- supporting training and education
- disseminating results and findings
- facilitating the export of Canadian technologies to international markets
- engaging in international co-operation

Specific work includes the development of design, modelling and analysis tools and integrated design approaches, such as building energy simulation software making it possible to achieve greater energy efficiency to be implemented at minimal incremental costs. CanmetENERGY develops, distributes and supports building energy simulation software for the Canadian construction industry and Government of Canada ecoACTION programs.

CanmetENERGY is active in the R,D&D of energy-efficient heating, ventilation, air-conditioning and refrigeration technologies, including standards, efficiency labelling, heat recovery systems, integration of technologies and adaptation to the Canadian context. CanmetENERGY assists in increasing the use of solar thermal and solar photovoltaic energy technologies in Canada by developing technologies, standards, policies and programs to create a Canadian-based, globally competitive solar industry. Other work includes community energy systems, daylighting, intelligent building controls and recommissioning of buildings.

CanmetENERGY's partnerships with industry help to build advanced residential and commercial buildings that incorporate a wide array of innovative technologies and consume significantly less energy than their conventional counterparts. Under cost-sharing arrangements to accelerate the development and commercialization of a new generation of advanced and energy-efficient technologies, CanmetENERGY is helping the Canadian residential and commercial building industry produce some of the most environmentally advanced structures on the planet.

Key 2007–2008 Achievements

- CanmetENERGY is helping to update the *Model National Energy Code for Buildings*, the revised version of which will be released in 2012. In 2007–2008, the Standing Committee on Energy Efficiency in Buildings was formed, as were five task groups. CanmetENERGY is a member of the Task Group on Building Envelope and the Task Group on Building Energy Performance Compliance. A scoping exercise for each task group was undertaken, and funding has been put in place.
- CanmetENERGY increased the number of users of the RETScreen®[8] Clean Energy Project Analysis Software to more than 147 000 people in 222 countries, adding an average of 1000 new users every week. More than 160 colleges and universities worldwide are now using RETScreen for education. As well, CanmetENERGY launched a major new version of the RETScreen software, including a suite of new models to evaluate energy efficiency measures for residential, commercial and institutional buildings; communities; and industrial facilities and processes.
- CanmetENERGY facilitated the successful technology transfer and demonstration of a combined photovoltaic and solar thermal hybrid technology with the Solar Buildings Research Network, headquartered at Concordia University. The Network developed and implemented a strategy to effectively transfer this knowledge to architects, manufacturers, home builders and utilities.
- CanmetENERGY and Doug Tarry Homes Ltd. piloted the Solar Ready homes project, which required the builder to incorporate defined criteria into its construction designs and practices in order to accommodate solar hot-water technology.
- CanmetENERGY is facilitating the integrated design process, a new approach to designing, to enable a new laboratory to relocate NRCan employees to McMaster University in Hamilton, Ontario. The objective is to achieve the highest levels of energy efficiency, reduce energy bills and minimize the use of program funding for building operations.
- CanmetENERGY continues to see the benefits of its work with industry leaders in heating refrigeration systems. CIMCO Refrigeration developed its ECO CHILL® system with NRCan technical support and expertise and has been selected to provide all refrigeration systems where heating and refrigeration are required at the Vancouver Olympic games.

[8] RETScreen is a registered trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

- Ice Kube Systems Ltd. (IKS) has signed an agreement to demonstrate the application of IKS modular refrigeration/heat-pump units integrated with underground thermal energy storage for district energy. This integrated system will supply 240 tonnes of refrigeration to a multi-pad indoor arena and ensure the recovery and re-use of almost 100 percent of the heat rejected by the refrigeration process.
- CanmetENERGY developed a Canadian Advanced Recommissioning (RCx) course and delivered two workshops in collaboration with NRCan's Office of Energy Efficiency, BC Hydro and Union Gas Limited. The RCx course is part of CanmetENERGY's commitment to develop RCx training programs, guidelines and tools to help create awareness and promote best practices that reduce energy consumption and improve the performance of building systems.
- CanmetENERGY developed the Sustainable Urban Neighbourhood (SUN) process, which was piloted during the design of the mixed-use Emerald Hills Urban Village in Strathcona County, Alberta. SUN offers an approach for translating broader concepts of sustainable development and living, including energy efficiency, alternative energy and reduced water use, into applications at the neighbourhood level.
- CanmetENERGY develops and supports building simulation software for the Canadian housing industry. Last year, its HOT2000[9] software was used to run simulations for energy efficiency upgrades on 106 701 Canadian houses, bringing the total to date to 386 307.

For more information:

canmetenergy.nrcan.gc.ca/eng/buildings_communities.html

CLEAN ELECTRIC POWER GENERATION

Objective

To develop and apply technologies for renewable electricity production and for cleaner power generation from fossil fuels, with the goal of increasing efficiency and achieving the reduction and, ultimately, the elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances, such as mercury, trace elements and organic compounds.

Description

CanmetENERGY's work on clean electric power generation focuses on improving the economics and efficiency of renewable energy technologies, including wind energy, solar power, small and low-head hydro, marine energy and energy storage. CanmetENERGY's R&D supports the growth of the renewable energy industry in Canada by

- fostering the development of new technologies
- identifying and developing opportunities for the integration of renewables
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- conducting resource assessments

CanmetENERGY also focuses on improving the performance of, and reducing emissions from, existing fossil fuel power plants. Moreover, it focuses on developing new advanced cycles for the conversion of fossil fuels to electricity with complete or near-complete capture and elimination of CO_2 and other emissions. Additional research includes work on issues associated with the transport and storage of CO_2. Through advanced tools and technologies, CanmetENERGY assists major industrial energy consumers in reducing the energy intensity of their operations and in reducing GHG emissions and emissions of other air pollutants, while enhancing competitiveness and profitability.

[9] HOT2000 is an official mark of Natural Resources Canada.

CanmetENERGY's work on emerging technologies in clean power includes new forms of power generation, such as wind, small hydro, natural gas combined-cycle plants and advanced fluidized bed combustion. Significant R&D also focuses on CO_2-neutral combustion systems, CO_2 sequestration, CO_2 injection for enhanced oil recovery, advanced power generation cycles, clean coal technologies and distributed energy resources. CanmetENERGY also conducts leading-edge work in the burgeoning priority area of decentralized energy resources, where renewable energy sources are becoming more localized and integrated into the main grid.

CanmetENERGY addresses the technical, institutional and regulatory barriers to clean power by promoting grid integration, developing standards, generating knowledge and transferring important information to Canadian decision-makers. CanmetENERGY provides stakeholders with the necessary information to make informed decisions, coordinates various research projects, participates in international committees that establish standards and codes, develops and hosts workshops and conferences, develops publications and produces training tools. CanmetENERGY capitalizes on its sector expertise by carrying out projects in collaboration with key research consortia, including industry, universities, research groups, public services and other departments and governments.

Key 2007–2008 Achievements

- Advanced distributed generation models generated with the CYMDIST software were released, along with case studies. These models and case studies form the basis of tutorial material for utility engineers to improve their knowledge of renewable and distributed generation applications.
- Working with Electric Utility Consultants, Inc. (now called EUCI) and Canadian stakeholders, CanmetENERGY organized a national conference to discuss strategic and tactical issues in implementing a "smart grid" network in Canada. The smart grid serves an important role in facilitating energy efficiency programs and integrating renewable and distributed energy resources.
- CanmetENERGY was instrumental in establishing the International Electrotechnical Commission (IEC) Technical Committee 114 on Marine Energy. CanmetENERGY is chairing this 15-member committee, which will develop international standards. At the same time, CanmetENERGY, working with the Standards Council of Canada, established a mirror committee that will advise on the IEC standards development process to ensure that international standards reflect the development needs of a rapidly growing marine energy industry in Canada.
- Working with Agriculture and Agri-Food Canada and more than 20 agricultural and energy organizations across Canada, CanmetENERGY launched the Integration of Renewable Energy on Farms Web site. The site is a repository of technical information and online tools for analysing the potential for integrating renewable energy sources into individual farms. CanmetENERGY's expertise was used to develop, screen, validate and consolidate the best information available.
- After carrying out preliminary laboratory studies, CanmetENERGY installed an advanced 6-kilowatt (kW) micro-cogeneration system, coupled to a three-borehole heat storage system and heat pumps, at the Canadian Centre for Housing Technology (CCHT). The system demonstrated the capacity to supply all the heat and electrical energy required by CCHT and to return electrical energy to the grid at nearly three times the overall efficiency of a central power plant.

For more information:

canmetenergy.nrcan.gc.ca/eng/clean_fossils_fuels.html

CLEAN ENERGY SYSTEMS FOR INDUSTRY

Objective

To identify, encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, practices, products, systems and equipment in Canadian industry to improve its energy efficiency, productivity, competitiveness and profitability, while reducing GHG emissions and other environmental impacts.

Description

CanmetENERGY works with industry to co-manage and share the costs of development and commercialization of a range of technologies, including process integration, learning-based expert systems, combustion systems and controls, manufacturing processes, and environmentally friendly and energy-efficient processes for energy-intensive industries. CanmetENERGY's R&D in the industry sector focuses on plant-wide industrial process analysis techniques and advanced process control systems that identify and correct inefficiencies in plant operation and design while taking into account energy, economic and environmental aspects.

CanmetENERGY's R&D also includes the development and testing of semi-pilot-scale plants, pilot plants, prototypes and full-scale field trials. This research evaluates operating performance, energy efficiency and environmental impacts and emerging concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. In addition, CanmetENERGY disseminates technical information to encourage adoption of these techniques and practices in targeted energy-intensive sectors of Canadian industry.

CanmetENERGY clients are from a variety of industries, including pulp and paper, gas, oil upgrading and refining, petrochemicals, engine manufacturing, steel, chemicals, food and drink, solid wood, waste oil recycling and rendering, and specialty ceramic manufacturing. Its other clients are gas and electric utilities, equipment manufacturers and other governments.

Key 2007–2008 Achievements

- CanmetENERGY scientists and research engineers recently completed an important case study of Tembec Inc.'s Skookumchuck pulp mill in southeastern British Columbia. The study points the way to significant reductions in freshwater demands, effluent levels and energy consumption. Although the Skookumchuck mill is already one of the most water- and energy-efficient mills in Canada, the team found room for reductions of up to 20 percent in freshwater demand and the potential to increase the mill's power generation for export by approximately 4 megawatts. CanmetENERGY is developing software tools to capture the team's findings so water-intensive processes can be optimized throughout the pulp and paper industry.
- In co-operation with CANMET Mining and Mineral Sciences Laboratories (MMSL), the CANMET-MMSL Experimental Mine in Val-d'Or, Quebec, and Mining Technologies International Inc., CanmetENERGY is developing an energy-efficient diesel/electric hybrid scoop tram for mining operations. A prototype has been built and will undergo field testing shortly. The projected potential benefits over 10 years include more than 170 000 barrels of oil equivalent (BOE) in energy savings and almost 60 kilotonnes (kt) of CO_2 emissions reduction. Another environmental benefit is lower emissions of particulate matter through the displacement of small diesel engine use.
- In co-operation with the Natural Sciences and Engineering Research Council of Canada (NSERC), Hydro-Québec, Rio Tinto Alcan and the Université de Sherbrooke, CanmetENERGY launched the NSERC Chair in Industrial Energy Efficiency. The projects and prototypes that are developed will be relevant to many areas of activity and primarily target industrial applications.

- CanmetENERGY is working with Hatch of Mississauga, Ontario, to develop a continuous reduced iron and steelmaking process that improves energy efficiency, reduces costs and enhances competitiveness. The process could save over 60 terajoules (TJ), or 10 000 BOE, per year and lower emissions by 50 kt per installation.
- With CanmetENERGY support, Murox of Boucherville, Quebec, is developing an energy-efficient wall for the commercial, industrial and institutional construction markets. Once commercialized, the projected potential impacts of the wall over 10 years will be energy savings of 685 TJ (112 000 BOE) and CO_2 emissions reductions of 48 kt.
- CanmetENERGY is working with EMPCO (Canada) Ltd. of Whitby, Ontario, on a new slag door for electric arc furnace steelmaking applications. Making the door airtight will ensure that less air infiltrates the furnace chamber, yielding a more energy-efficient process. Over the next 10 years, energy savings could amount to over 3.4 PJ (550 000 BOE), and CO_2 emissions could be reduced by 2 megatonnes.
- CanmetENERGY is working with Airex Industries of Montréal to develop equipment for the recovery and use of waste heat. Adopters of this technology could save 5 PJ (865 000 BOE) and reduce CO_2 emissions by 260 kt.

For more information:

canmetenergy.nrcan.gc.ca/eng/industrial_processes.html

ENVIRONMENTALLY SUSTAINABLE OIL AND GAS DEVELOPMENT

Objective

To provide S&T for the continued, secure supply of affordable and cleaner fossil fuels, with little or no adverse environmental impact on GHG and Criteria Air Contaminants (CAC) emissions, and thereby help resolve oil sands environmental (including water) issues and clean air issues for the upstream oil and gas industry.

Description

CanmetENERGY conducts fundamental and applied research to develop knowledge and implement leading-edge technologies for the oil sands sector. Knowledge gained is used to inform energy policy development and industry decisions that will improve the quality of life for Canadians.

CanmetENERGY fosters innovation in oil sands and heavy oil technology through activities ranging from fundamental science to commercial-scale technical support. CanmetENERGY's strength lies in its staff's fundamental understanding of the chemistry, physics and engineering of oil sands and heavy oil processes, coupled with sophisticated analytical instrumentation and pilot-scale units providing proof of concept for technologies.

S&T is one tool used by NRCan to make significant progress toward meeting its water and tailings, GHG and other air emissions challenges in the oil and gas sector. Major improvements need to be made in the entire process chain of oil sands and heavy oil development, from the initial extraction to the production of petroleum products. CanmetENERGY's international client base and partnerships with provincial and territorial governments, industry and academia ensure that the best available technologies in the world can be modified and applied to the resource. Its partnerships also ensure there are synergies and fast-track deployment of new technologies, innovations and knowledge dissemination.

Key 2007–2008 Achievements

- CanmetENERGY worked on fundamental clay-water chemistry interactions. This is important for defining the consolidated tailings (CT) "recipe." From this fundamental work, a variety of CT chemicals were evaluated, including CO_2. A major project was undertaken on a key requirement for commercialization – the direct sequestration of CO_2 from surface-mined oil sands. The project has identified additional alternative chemicals for the dry stackable tailings activity.
- CanmetENERGY conducted research to gain an understanding of the impact of bitumen chemistry on extraction processes (through interactions with clays). Some of the work involved collaboration with Environment Canada and led to several publications. As a result of the fundamental knowledge acquired concerning the importance of bitumen chemistry in extraction processes, a small project with Titanium Corporation Inc. was launched. In this project, bitumen and naphtha would be removed from the valuable mineral component in froth treatment tailings. This prompted the Government of Alberta to contribute $3.5 million for investigating and commercializing some bitumen and naphtha removal technologies.
- Suncor Energy Inc.'s water chemistry model underwent significant reworking to incorporate it in the company's new mine plans. CanmetENERGY also completed a study on the fate of naphthenic acids in oil sands related systems. Initial results indicated that clean clays do not provide a sink as hypothesized but organics do provide a sink.
- A comprehensive client-funded project was just completed using CanmetENERGY's pilot plants, distillation unit, coker, hydrotreater and advanced cracking evaluation unit. CanmetENERGY worked with British Petroleum to simulate the optimal processing scheme for upgrading and refining Canadian bitumen. Their aim was to produce clean transportation fuels, while minimizing energy consumption during the process and removing sulphur to meet stringent ultra-low sulphur contents in fuels. Such conversions by industry are necessary to meet the proposed increases in bitumen production from Alberta.
- The CANMET Hydrocracking Process is designed to process highly aromatic feeds such as bitumen, resulting in 100 percent conversion of the feed with no waste by-products. It was developed in co-operation with Petro-Canada, which built and operated a 5000-barrels-per-day demonstration facility in Montréal. CanmetENERGY scientists are also working with Universal Oil Products (UOP) to provide pilot-plant testing, consultation and analysis of historical and new data. This resulted in UOP signing a licensing agreement and a $1.4-million contract with NRCan for pilot-plant support while UOP builds its own pilot plant.

For more information:

canmetenergy.nrcan.gc.ca/eng/oil_sands.html

CLEAN TRANSPORTATION ENERGY

Objective

To develop and deploy, in partnership with industry, academia and the provinces and territories, leading-edge hydrogen, fuel cell and transportation technologies that reduce GHG emissions and minimize urban air pollution.

Description

CanmetENERGY works with stakeholders in the domestic and international hydrogen and transportation technology industries. These industries include original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency. Together they develop and deploy innovative cleaner transportation technologies and alternative fuels.

R&D partnerships advance the development and deployment of innovative technologies, standards and infrastructure development, propulsion systems, engine controls, and energy and fuel storage systems. CanmetENERGY has worked with Canadian industry for more than 20 years to establish Canada as a world leader in fuel cell and hydrogen-refuelling technologies. It has supported student vehicle challenges since the 1980s. These challenges bring university and college students from across North America and automotive manufacturers together for the purpose of modifying existing vehicles so they can run on a variety of alternative fuels. CanmetENERGY supports the development of alternative transportation fuel technologies, such as those for natural gas, biodiesel and ethanol vehicles, to strengthen a Canadian industry that is now exporting commercial products.

CanmetENERGY managed the Canadian Transportation Fuel Cell Alliance, a private- and public-sector initiative aimed at developing the infrastructure needed to deploy hydrogen-fuelled vehicles. It also evaluated options for the production and delivery of hydrogen for light-, medium- and heavy-duty vehicles and monitored the resulting GHG reductions. Moreover, it developed training, certification and safety standards in support of hydrogen and fuel cell technologies. Fiscal 2007–2008 was the final year of the program.

Key 2007–2008 Achievements

Research and Development

- Optimized the material composition and fabrication process for hydrogen storage for use in micro fuel cell applications. An early application for this technology may be to replace batteries in cell phones with hydrogen fuel cells that can recharge in five minutes and run twice as long as a standard cell phone.
- Developed a high-density compact rechargeable battery system for electric vehicles that shortens charge time, increases vehicle range and improves safety. This 0.5-kWh lithium-ion battery module will serve as the building block for plug-in hybrid electric vehicles.
- Completed the modelling, detailing and optimization of a gasification process for large-scale hydrogen production for potential use in Canada's oil sands. This process is based on the iron-to-iron oxide cycle and provides for sequestration of a separate CO_2 stream.

Demonstration

- Established a hydrogen-fuelling station in Prince Edward Island, which is fuelling two Ford hydrogen internal combustion engine shuttle buses. The hydrogen is produced from wind power at North Cape and demonstrates the utilization of renewable energy in the transportation sector.
- Four stationary fuelling stations and one mobile fuelling station are operating in British Columbia as part of the Hydrogen Highway™. The five Ford Focus fuel-cell cars successfully completed their third year of on-road testing and evaluation in the Vancouver and Victoria areas, accumulating 186 000 kilometres of use.
- A hydrogen-fuelled airport tugger is being operated by Air Canada in a demonstration project underway at Vancouver International Airport.
- Commissioned a self-serve, fast-fill hydrogen-fuelling station using waste hydrogen in North Vancouver. The project serves to increase Canadian capacity for capturing and purifying industrial waste hydrogen. Canada is the world's largest hydrogen producer per capita, and waste hydrogen has significant potential to become an important Canadian resource.

For more information:

canmetenergy.nrcan.gc.ca/eng/transportation.html

SUSTAINABLE BIOENEGY

Objective

To assist Canadian industry in the R,D&D of bioenergy technologies, thereby increasing the production and use of bioenergy, which generates environmental and economic benefits.

Description

CanmetENERGY supports the R,D&D of bioenergy technology through cost-shared agreements, promotes bioenergy as a renewable and sustainable energy source, advocates the need for proper policies and programs relating to bioenergy, and raises the public's and policy makers' awareness of the benefits of bioenergy.

CanmetENERGY's biomass energy conversion technology expertise covers the following main processes:

- combustion – converting forestry, agricultural and municipal residues into heat and power under environmentally sound conditions
- gasification – converting forestry, agricultural and municipal residues into syngas
- pyrolysis – converting forestry and agricultural residues into bio-oils and value-added products
- fermentation – converting the starch and cellulose components in biomass into bio-ethanol
- transesterification – converting a variety of new and used vegetable oils, tallow and yellow grease into bio-diesel
- anaerobic digestion – converting manures and food-processing and municipal wastes into methane-rich biogas

Activities focus on improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry demonstrate its products in domestic and foreign markets.

Initiatives include R,D&D, technical and socio-economic studies, end-use demonstrations and testing, feasibility studies, process analysis, verification, testing and improvement, standards development, emissions reductions, modelling, conference and workshop support, information dissemination, International Energy Agency collaboration and committees, stakeholder education, and standards development.

CanmetENERGY plays a leadership role in the Canadian Biomass Innovation Network, a multi-departmental working group formed to direct federal R&D on bioenergy and bioproducts. Clients include the agricultural and forestry sectors (biomass producers and bioenergy consumers), municipalities and industrial partners. (For more information, see "Canadian Biomass Innovation Network," in the next section.)

Key 2007–2008 Achievements

- With CanmetENERGY support, Powerbase Energy Systems Inc. recently built 3175-kW combined heat and power containerized units to be demonstrated on working farms in eastern Ontario. These units are fully automated. They include biogas and anaerobic digester management controls, heat exchangers for farm heat supply, the electronic controls needed to sell electricity to the grid, and safety equipment.
- CanmetENERGY provided R,D&D support and laboratory expertise to Enerkem Inc. for the development of a thermochemical process producing cellulose-based ethanol. The process involves the gasification of biomass to syngas and the subsequent catalytic conversion of syngas to methanol and, finally, to ethanol. The company has taken the technology from lab scale to pilot scale at its Sherbrooke, Quebec, facility. Now it is building a large-scale demonstration unit in nearby Westbury, Quebec.
- CanmetENERGY worked with Vaperma Inc., an advanced gas separation company, to develop the Siftek™ membrane. The membrane can separate ethanol-water mixtures over a wide range of water concentrations, ultimately producing fuel-grade ethanol. Vaperma is working on a second-generation membrane that could be used for cellulosic ethanol.
- CanmetENERGY's support of R,D&D activities with Nexterra Energy Corp. contributed to recent successes. The first was the sale of a multi-million-dollar biomass gasification system to Dockside

Green Power Limited. Another success was the strategic alliance formed with Johnson Controls, Inc., a global leader in facility management and control. Nexterra's biomass gasification solutions were offered to Johnson Controls customers in such sectors as higher education, health care, government facilities and industrial operations. Nexterra recently won the prestigious GLOBE Award for Technology Innovation and Application for outstanding achievement in environmental stewardship.

For more information:

canmetenergy.nrcan.gc.ca/eng/bioenergy.html

CANADIAN BIOMASS INNOVATION NETWORK

Objective

To develop sustainable and cost-effective technologies in bioenergy, biofuels, bioproducts and industrial bioprocesses for market acceptance while utilizing biomass resources in a sustainable and responsible way.

Description

The Canadian Biomass Innovation Network (CBIN) supports strategic R&D in bioenergy, biofuels, bioproducts and industrial bioprocesses to reduce fossil fuel energy consumption, directly or indirectly reduce GHG and CAC emissions, diversify the energy supply and seed the development of Canada's bio-based economy.

CBIN is a horizontal program developed and managed by five departments: Agriculture and Agri-Food Canada, Environment Canada, Industry Canada, the National Research Council and NRCan. CBIN coordinates and manages two federal government bio-based R&D initiatives:

- the PERD Bio-Based Energy Systems and Technologies program ($3.3 million in 2007–2008)
- the biotechnology R&D component of the Technology and Innovation Initiative ($5.8 million in 2007–2008)

Key 2007–2008 Achievements

- Developed an environmental assessment framework with environmental criteria validated under Canadian conditions for the placement of cellulosic bioethanol facilities. The data generated were considered critical to developing key elements of the architecture for the Renewable Fuels Strategy and subsequent research strategy. The data were used by Agriculture and Agri-Food Canada's ecoAgriculture Biofuels Capital Initiative, U.S. federal government agencies, four provinces (British Columbia, Alberta, Saskatchewan, Ontario) and 33 U.S. states for assisting in the optimal location of biofuels production and conversion facilities.
- Created a comprehensive inventory of sustainable sources of woody and crop residue biomass that is incorporated in the Biomass Inventory Mapping and Analysis Tool (BIMAT). The inventory identifies, at source, herbaceous and woody biomass feedstock availability, preliminary estimates of costs to recover and the type or characterization of feedstock and then represents the information as a map. BIMAT development has generated substantial interest in Canada, Europe and the United States. Demonstrations of the BIMAT are in the planning stage.
- Evaluated the replacement of natural gas with biomass-derived fuels for kiln-heating and power boiler applications to reduce energy requirements and GHG emissions. The use of biomass-derived fuels in lime kilns would introduce pulp and paper mills to conversion technologies, such as gasification and pyrolysis. This use would facilitate the conversion of biomass into value-added bioproducts, including ethanol, biodiesel and speciality chemicals, and set the stage for conversion of pulp mills into bio-refineries. Preliminary results indicate a potential for replacing more than 50 percent of natural gas with syngas, with minimal effects to regular lime kiln operations.

For more information:

cbin.gc.ca

CHAPTER 5

Renewable Energy

RENEWABLE ENERGY USE

In 2006, renewable sources accounted for approximately 61 percent of Canadian installed electricity capacity (see Table 5-1). Most of the renewable energy used in Canada comes from either hydroelectricity or thermal energy from biomass, such as wood-waste sources (see Table 5-2).

TABLE 5-1

Electricity Generation Capacity From Renewable Sources (includes hydroelectricity)

Year	Renewable electricity generation capacity (megawatts)	Total capacity (percent)
1990	59 557	58
1991	61 116	58
1992	62 895	58
1993	63 114	56
1994	63 175	56
1995	66 542	57
1996	67 101	59
1997	68 202	61
1998	68 340	62
1999	68 614	62
2000	69 031	62
2001	68 845	61
2002	71 032	62
2003	72 275	62
2004	72 947	60
2005	74 368	61
2006	75 812	61

Source: Statistics Canada, *Electric Power Generating Stations* (Cat. No. 57-206-XIB).

TABLE 5-2

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydroelectricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot water systems
Wind	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Biodiesel
	Ethanol from biomass

Hydroelectricity

Hydroelectricity is a renewable form of electricity generated from a system or technology that uses a mechanical method to capture and convert the potential energy of water.

Hydro is the main source of electricity in Canada, accounting for approximately 60 percent of the electricity generated in 2005. Canada's hydro supply is dominated by large-scale projects that were developed by electric utilities. Of the 72 661 megawatts (MW) of installed hydro capacity, 3421 MW come from small hydro sites (capacity less than 50 MW), equal to about 2.8 percent of Canada's total installed electricity capacity. Significant potential remains for additional hydroelectric development in most provinces and territories.

Biomass

Bioenergy is a renewable source of energy derived from the conversion of matter from living organisms or metabolic by-products. Canada has an abundant supply of many types of biomass, which is important for the production of energy, biofuels, materials and chemicals. The two largest sources of biomass supply in Canada are forestry and agricultural operations.

Biomass supply typically takes the following forms:

- forestry – mill or pulp-and-paper residues, black liquor from the pulping process, forest residue, forest management thinnings and short rotation crops
- agriculture – agricultural crops, crop residue, processing residues, algae and aquatic biomass
- other organic waste – animal waste, such as manure from feed lots, municipal solid waste and industrial wastes

Approximately 4.6 percent of Canada's energy supply comes from bioenergy. This amount of renewable bioenergy ranks second to hydro power (which generates 11.5 percent of Canada's energy). Most of the bioenergy produced is in the form of industrial process heat, electricity and residential space heating.

The pulp and paper industry is Canada's major producer and user of bioenergy. Heat and electricity produced by industry, electricity generated by independent power producers, and residential wood heat are considered commonplace in Canada's energy mix. For example, approximately 3 million Canadian households use wood for home heating. Roundwood is typically used but alternatives include wood chips and pellets. Wood for home heating is usually burned in stand-alone wood stoves, wood furnaces with hot water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters.

Biogas and landfill gas (methane-rich gases that are derived from manure, animal processing wastes, other agricultural residues and municipal waste) for energy production is just emerging. The gases contributed just over 111 MW of power in 2006.

Biomass also shows potential as a feedstock for liquid fuels. Approximately 200 million litres of fuel ethanol are produced annually in Canada from cereal grain and corn. Biodiesel is also produced in small quantities, but production is increasing. Canada has potential to increase its bioenergy production in a sustainable manner.

Earth Energy

As a result of the sun heating the surface of the planet, and because of the insulating qualities of the earth itself, the temperature 1 or 2 metres below the surface remains fairly constant – between 5°C and 10°C. This temperature is warmer than that of the air during the winter and cooler than that of the air in the summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or groundwater as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, a ground-source heat pump is known as an earth energy system (EES).

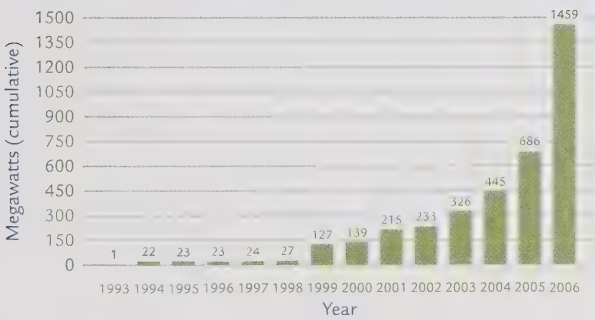
During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution or water that circulates within an underground loop. The EES then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with potential estimated at more than 100 000 MW. As of December 2006, a total of 1459 MW of wind power was installed in Canada. This amount makes Canada the thirteenth country that has reached the 1000-MW milestone and the country with the twelfth-largest installed wind energy capacity. For Canadian wind power, 2006 was a record year, with a 113 percent increase over the 2005 level (1459 MW compared with 686 MW). Recent policy developments have spurred record growth in the Canadian wind generation industry (see Figure 5-1). Wind energy currently accounts for approximately 0.6 percent of Canada's total electricity generation, up from 0.4 percent in 2005.

FIGURE 5-1

Canadian Wind Power Capacity, 1993 to 2006



Source: Canadian Wind Energy Association

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies – buildings are designed and located to maximize their reception of solar energy
- active solar thermal systems – solar radiation is converted into thermal energy for heating air or water in residential, commercial and industrial applications
- solar electric (photovoltaic [PV]) systems – solar radiation is used to produce electricity

The Canadian active solar thermal installed capacity in 2005 was 419 000 square metres (m^2), or 290 $MW_{thermal}$. The domestic market increase has averaged 17 percent annually since 1998. In 2005, the solar thermal collector market in Canada was 61 500 m^2, compared with 53 600 m^2 in 2004.

The Canadian total PV installed capacity in 2006 was 20.5 MW, with a sustained domestic market growth that has averaged 22 percent annually since 1992. In 2006, the PV module market in Canada was 3.75 MW, compared with 3.68 MW in 2005.

Natural Resources Canada carries out two initiatives to increase the use of small-scale renewable energy in Canada: ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat. They are outlined below.

ecoENERGY FOR RENEWABLE POWER

Objective

To encourage the production of 14.3 terawatt hours (TWh) of electricity from low-impact renewable energy sources (about 4000 MW of new capacity), such as wind, hydro, biomass, solar PV and ocean energy, between April 1, 2007, and March 31, 2011.

Description

The ecoENERGY for Renewable Power program provides an incentive of one cent per kilowatt hour to an eligible low-impact renewable energy project for up to 10 years. Eligible recipients include businesses, institutions/organizations, independent power producers, public and private utilities, and co-operatives that install qualifying renewable power systems. Qualifying projects must have a total rated capacity of 1 MW or greater.

Targets

By 2011, the program will have contributed to the annual generation of 14.3 TWh of electricity or about 4000 MW of capacity, depending on the mix of energy sources supported under the program. At present, these energy savings convert to annual emissions reductions of between 6 and 6.7 megatonnes of GHGs and related Criteria Air Contaminants (CAC) emissions.

Key 2007–2008 Achievements

- Program was launched April 1, 2007.
- 171 projects were registered, representing more than 11 000 MW of capacity.
- 12 contribution agreements were signed with proponents, representing about $305 million in federal funding over 10 years and 948 MW of new renewable power capacity.

For more information:

ecoaction.gc.ca/ecorp

ecoENERGY FOR RENEWABLE HEAT

Objective

To increase the use of renewable energy technologies, develop thermal energy industry capacity and contribute to the reduction of harmful emissions.

Description

The ecoENERGY for Renewable Heat program supports renewable thermal technologies used for space heating and cooling and water heating, through a mix of deployment incentives, residential pilot projects and industry capacity-development funding:

- deployment incentive – providing a financial contribution to encourage the deployment of solar thermal units in the industrial, commercial and institutional sectors
- residential pilot projects – providing financial contributions to test, through collaborative ventures, various approaches to the delivery of solar water-heating projects to encourage the deployment of solar water-heating units in the residential sector
- industry capacity-development – providing financial contributions to develop technology standards, certification procedures for solar thermal technologies, human resources skills and tools for renewable thermal technologies and to provide public information on renewable thermal energy technologies

Targets

It is estimated that, by 2011, this program will result in energy savings of 0.35 petajoules. At present, these energy savings convert to annual emissions reductions of about 20 kilotonnes of GHGs and related CAC emissions.

The emissions reduction expectations are derived from assumptions regarding the displacement of fossil fuel energy used for space heating and water heating in Canada's building and housing stock, based on current energy consumption profiles. Actual emissions reductions achieved will depend on project parameters, such as the efficiency of the heating equipment in use, the type of fuel displaced, the solar thermal unit output and the thermal loads being applied to the solar units deployed.

Key 2007–2008 Achievements

- Received 369 funding applications from industrial, commercial and institutional sectors to install solar air and solar hot-water systems and signed over 200 contribution agreements with successful applicants, representing about $6 million in federal funding.
- Developed a pilot project that will provide incentives that will result in the installation, by utilities, developers and buyers' groups, of 8000 solar water-heating systems in Canadian homes over the three remaining years of the program. It will also set the stage for the transformation of the Canadian water-heating market.
- Established a partnership with two provincial governments and renewable energy industry associations.

For more information:

ecoaction.gc.ca/heat

CHAPTER 6

Co-operation

INTRODUCTION

This chapter describes Natural Resources Canada's (NRCan's) co-operation with provincial and territorial governments and internationally on efficiency and alternative energy (EAE) during the reporting period. Examples of program co-operation on specific EAE initiatives are in the "Key Achievements" sections in earlier chapters.

Municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (e.g. in anti-idling projects). At the same time, NRCan participates in ventures led by municipal organizations, such as the Green Municipal Fund (see accompanying textbox), and by provincially and territorially regulated electricity utilities and provincially regulated natural gas utilities.

Several institutions in Canada address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies, and various associations and energy supply utilities. Their main objectives are to facilitate access to data on energy use in the industry, transportation and building sectors; monitor the quality of data; and investigate methods of improving data collection and analysis.

There are two national consultative bodies in the area of energy efficiency: the Assistant Deputy Minister Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers; and the Office of Energy Efficiency's (OEE's) National Advisory Council on Energy Efficiency (NACEE).

Green Municipal Fund

The Government of Canada endowed the Federation of Canadian Municipalities (FCM), a non-profit organization, with $550 million to establish the Green Municipal Fund (GMF) for the purpose of providing a long-term, sustainable source of funding for municipal governments and their partners. The GMF invests in plans, studies and projects that offer the best examples of municipal leadership in sustainable development and that can be replicated in other Canadian communities.

Under the GMF agreement, the Government of Canada (represented by NRCan and Environment Canada) participates in governance of this revolving fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council. The FCM board of directors approves projects in light of the council's recommendations.

As of March 31, 2008, the GMF had approved over $375 million for 690 plans, studies and projects with a total project value of $2.2 billion.

ASSISTANT DEPUTY MINISTER STEERING COMMITTEE ON ENERGY EFFICIENCY

In 2004, federal, provincial and territorial energy ministers established the ASCEE and tasked it with establishing a coordinated, complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held seven meetings in 2007–2008, with members representing the federal, provincial and territorial governments.

There are three working groups under the auspices of the ASCEE. In 2007, these groups contributed to the development of the Council of Energy Ministers' document *Moving Forward on Energy Efficiency in Canada: A Foundation for Action.*

- Formed in 2003, the Demand Side Management Working Group (DSMWG) has members representing NRCan, industry and all provinces and territories. The DSMWG has initiated studies on such subjects as demand side management potential in Canada, best practices in performance measurement, and reporting and regulatory frameworks.

  The ASCEE sponsored the formation of the Transportation Working Group on Energy Efficiency (TWGEE) in 2005. Its mandate is to assess the status and enhance the alignment of transportation energy efficiency activities across federal, provincial and territorial jurisdictions and to investigate opportunities for further collaboration and new initiatives. The TWGEE comprises government officials from federal and provincial energy and transportation departments and ministries.
- The Industry Working Group on Energy Efficiency was formed in 2006. It promotes information exchange among industrial energy end-users and authorities, agencies, utilities and jurisdictions involved in the design, development and delivery of industrial energy efficiency programming in Canada.

NATIONAL ADVISORY COUNCIL ON ENERGY EFFICIENCY

NACEE was created in April 1998 to assist the OEE as an innovative government organization by

- assessing and advising on the OEE's strategic approach to meeting federal policy objectives
- advising the OEE on its performance and business planning and reporting on progress
- considering issues related to accelerating growth in energy efficiency in the Canadian economy

NACEE membership is drawn from across Canada. It includes representatives from various levels of government, academia, economic sectors, energy utilities and advocacy groups. NACEE met three times during 2007–2008.

FEDERAL-PROVINCIAL AND FEDERAL-TERRITORIAL CO-OPERATION

Interest continues to grow in energy efficiency as a means of maximizing services based on the existing energy supply capacity in the country. In addition to general co-operation on energy efficiency, provincial and territorial governments helped to deliver tools, or employed tools provided by federal EAE programs, to reduce energy costs, address climate change, increase competitiveness, improve air quality and create economic opportunities. Coordination between the federal and provincial/territorial levels avoids duplication and ensures efficient program delivery.

All provinces and territories engage in energy efficiency activities and/or deliver energy efficiency programs in their jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency. For example, one of the objectives of Alberta's Climate Change Central is to focus on information and action on energy efficiency and conservation in the province. The Office of the Fire Commissioner of Manitoba is

engaging stockholders in a review of the Energy Code Advisory Committee recommendations, the introduction of water efficiency in the plumbing code and the identification of barriers in the *Manitoba Building Code* to energy and water efficiency in buildings. The Ontario Power Authority's Conservation Bureau provides leadership in planning and coordinating measures for electricity conservation and load management. The Canada–Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power.

Recently, there has been a greater focus on energy efficiency in the Maritime provinces, as evidenced by the creation of three agencies: Efficiency NB, Conserve Nova Scotia and Prince Edward Island's (P.E.I.'s) Office of Energy Efficiency. Efficiency NB's mandate is to promote efficient energy use, help control energy expenses and lessen the impact of energy use on the environment, while P.E.I.'s Office of Energy Efficiency provides advice and programs to promote sustainable energy use. Other regional organizations of note are the Arctic Energy Alliance in the Northwest Territories, the Nunavut Energy Centre and the Agence de l'efficacité énergétique du Québec.

Use of Federal EAE Program Tools by Utilities, Provinces and Territories

Provincial and territorial governments and utilities use federal EAE program tools to complement their own energy efficiency programs. Here are some examples:

- Homeowners in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, British Columbia, Yukon and the Northwest Territories can access both provincial/territorial and federal home retrofit programs through a single energy evaluation offered under ecoENERGY Retrofit – Homes. The ecoENERGY evaluation and its criteria are also used by these jurisdictions to determine eligibility for incentives.
- Canadians in most provinces and territories can benefit from rebates and sales tax exemptions on selected ENERGY STAR® products. The ENERGY STAR program is administered by the OEE and is used by a number of provinces and utilities as a qualifying criterion.
- NRCan's R-2000 Standard is used by utilities in Saskatchewan, Manitoba and Newfoundland and Labrador as a qualifying criterion for incentives and rebates designed to encourage the construction of energy-efficient new homes.
- Most of the provincial and territorial bodies responsible for driver education use the Auto$mart Driver Education Kit, developed by the OEE, to educate young drivers on fuel efficiency. For example, Manitoba Public Insurance has recently incorporated an Auto$mart component into its curriculum, and many provinces display the OEE's publications in their licensing bureaus.

The Building Energy Codes Collaborative

The Building Energy Codes Collaborative (BECC) is a provincial-territorial-federal committee supported by the Council of Energy Ministers, ASCEE and NRCan. BECC is made up of representatives from provincial/territorial code and energy ministries, departments and agencies; NRCan; and the Canadian Codes Centre. The objectives of the BECC are as follows:

- provide a forum for provinces, territories and the federal government to support the update, regulatory adoption and implementation of the *Model National Energy Code for Buildings* (MNECB) by responsible authorities
- work in co-operation with the provinces and territories and the Canadian Commission on Building and Fire Codes toward a national consensus on establishing energy efficiency in the code process
- explore other regulatory and/or program instruments for increasing energy efficiency in new housing, including updating the MNECB
- seek support from the federal government and the energy and building code ministries in the provinces and territories and engage their representatives in the process

NRCan and BECC prepared a business plan for updating the MNECB and presented it to the Canadian Commission on Building and Fire Codes. Commission members unanimously approved the following motion at its annual meeting in Calgary in February 2007: ". . . that the updating of the MNECB as a progeny document based on the BECC Business Plan be approved."

NRCan then prepared and signed a memorandum of understanding with the National Research Council (NRC). NRCan is contributing up to $5 million over four years to support the technical development of the new code and is providing technical expertise to the NRC team tasked with developing national codes. The NRC launched the project, and the Standing Committee on Energy Efficiency in Buildings held its first meeting on updating the code in Ottawa in December 2007.

The updated MNECB will be published by 2011 in an objective-based format. It will complement objective-based model national construction codes published in 2005.

Co-operation Agreements

NRCan's memorandum of agreement (MOA) on EAE with the Agence de l'efficacité énergétique du Québec provides for the consultation and sharing of information between the two governments, the coordination of EAE activities in Quebec and the creation of opportunities for joint projects. Further, the management committee established under the MOA reviews policy and program developments, progress on joint program initiatives and areas for further co-operation. NRCan is working with the Agence de l'efficacité énergétique to deliver services under the ecoENERGY programs.

The MOA played a role in facilitating three activities in particular:

- management of the licensing agreement for local delivery of ecoENERGY Retrofit – Homes
- NRCan's Buildings Division's continued processing of payments for the former EnerGuide for Existing Buildings and Commercial Building Incentive programs under a letter of co-operation (LOC) with the Agence de l'efficacité énergétique that covers 2007–2008 and 2008–2009. Though the two programs are closed, payments, which can be made only when the client proves to NRCan that work has been completed, are still being processed.
- management of an agreement on the Programme d'intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec ice rinks

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information sharing and the creation of opportunities for joint projects in Yukon. These projects include the Canada–Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to technical services and programs for the Yukon population and undertakes outreach and public education activities.

NRCan works co-operatively with the Office of the Fire Commissioner of Manitoba, a special operating agency of Manitoba Labour and Immigration, to engage Manitoba stakeholders in a review of the Energy Code Advisory Committee recommendations. Manitoba is also consulting stakeholders on introducing water efficiency in the plumbing code and identifying barriers in the *Manitoba Building Code* to energy and water efficiency in buildings. The result will be a stakeholder consultation report provided to Manitoba's Minister of Labour and Immigration and Minister of Science, Technology, Energy and Mines.

The Government of Canada contributes to the Arctic Energy Alliance as a means of promoting energy efficiency and renewable energy in the Northwest Territories and providing opportunities for EAE projects. The Alliance is also the R-2000 delivery agent in the Northwest Territories. Through the contribution agreement with the Qulliq Energy Corporation, the Government of Canada contributes to the Nunavut Energy Centre, which promotes energy efficiency and renewable energy in Nunavut.

NRCan works with Ontario's Ministry of Small Business and Entrepreneurship, the Independent Electricity System Operator and local distribution companies to provide energy management training to individual companies across Ontario through Dollars to $ense workshops.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a non-profit corporation funded by a number of stakeholders, including the Government of Alberta.

Sustainable Development Technology Canada – NextGen Biofuels Fund™

The NextGen Biofuels Fund™ is a $500-million program scheduled to run from 2008 to 2017. Responsibility for the program is held jointly by NRCan and Environment Canada. The fund is managed under the auspices of Sustainable Development Technology Canada (SDTC.)

The NextGen Biofuels Fund™ aims to facilitate the establishment of first-of-a-kind, large, demonstration-scale facilities for the production of next-generation biofuels and co-products in Canada; improve the sustainable development impacts arising from the production and use of biofuels; and encourage retention and growth of technology expertise and innovation capacity for the production of next-generation biofuels.

Next-generation renewable fuels are derived from non-traditional renewable feedstocks – such as forest biomass, fast-growing grasses and agricultural residues – and are produced with non-conventional conversion technologies. An eligible project must use feedstocks that are or could be representative of Canadian biomass, and the technology must have been demonstrated at the pre-commercial pilot scale. SDTC will support up to 40 percent of eligible project costs.

INTERNATIONAL CO-OPERATION

NRCan co-operates with several international organizations and foreign governments in EAE program areas. Canada benefits from this co-operation by

- learning about improved ways of designing and delivering EAE programs to meet policy objectives
- working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products

International Energy Agency

The International Energy Agency (IEA), based in Paris, France, is an autonomous agency of the Organisation for Economic Co-operation and Development. The IEA runs a comprehensive program of energy co-operation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and co-operating on the development of rational energy programs incorporating energy security, economic development and environmental protection. The IEA and its governing board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Co-operation (SLT) is the key committee on the policy side. The Group analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil, and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The SLT's Energy Efficiency Working Party (EEWP) provides advice on and direction to the IEA's work on specific energy efficiency issues. The OEE represents Canada on the EEWP.

Canada's international energy research and development (R&D) objectives are mainly advanced through the IEA's working parties, implementing agreements and the Committee for Energy Research and Technology, chaired by NRCan. Canada participates in 32 of the IEA's 40 implementing agreements on R&D collaboration programs. NRCan spent $752,000 on IEA implementing agreements in 2007–2008, in addition to personnel and travel expenditures. In many programs, this work has helped to accelerate technology development in Canada, generating benefits that far outweigh the direct costs of collaboration.

Canada also co-operates with research centres in member countries on several R&D and technology agreements and programs. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities. These activities include participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

Group of Eight

Member states of the Group of Eight (G8) are Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, the United States and the European Union. The G8 Summit in 2005 established the Gleneagles Plan of Action, which includes a number of actions in the area of EAE. While NRCan's participation in the IEA and international mechanisms for standards harmonization respond to many of the listed activities, others are implemented through NRCan's EAE programs.

At the G8 summit in 2007 in Heiligendamm, Germany, the leaders of the G8 countries and Brazil, China, India, Mexico and South Africa agreed to initiate a topic-driven dialogue under the "Heiligendamm Process." The Process has four pillars, and working groups have been formed around each one. Energy, with a special focus on energy efficiency, is one of the pillars. The Energy Working Group will explore the common ground

available for building international support for new ideas and approaches for increasing energy efficiency. It will focus on energy security, development of a sustainable buildings network, energy efficiency in power generation (particularly in existing power plants), and alternative sources of energy and renewable energy. Canada, represented by the OEE, is co-chair with India. The Working Group held its first meeting in March 2008.

Asia-Pacific Economic Cooperation

At the 2007 Asia-Pacific Economic Cooperation (APEC) Economic Leaders' Meeting, leaders highlighted the importance of improving energy efficiency in the Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development. The declaration endorsed an APEC-wide regional aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year).

The OEE is a member of the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C), which reports to APEC's Energy Working Group. One of the tasks of the EGEE&C is updating and maintaining the APEC Energy Standards Information System (ESIS). ESIS provides public, up-to-date information on appliance and equipment energy standards and regulations. It also provides links to experts and information related to standards and regulations used by APEC and other economies. NRCan contributes regularly to the database by providing updated information on Canadian equipment standards and labelling and new initiatives, such as the phase-out of incandescent lamps.

United Nations

RETScreen® International is managed under the leadership of NRCan's CanmetENERGY Varennes (QC) Research Centre. RETScreen is managed through cost- and task-shared collaborative ventures with other governments and multilateral organizations, and with technical support from more than 250 experts representing industry, government and academia. Key partners are NASA's Langley Research Center and the Renewable Energy and Energy Efficiency Partnership. Other key international partners include the Energy Branch of the United Nations Environment Programme (UNEP) and the UNEP Solar and Wind Energy Resource Assessment, which is sponsored by the Global Environment Facility.

Mexico

NRCan signed a memorandum of understanding (MOU) on EAE co-operation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and by fostering trade, investment, technical and other exchanges related to energy-efficient products, energy management services, and alternative energy goods and services. Under the MOU, officials of Mexico's National Commission for Energy Savings (CONAE) participated in an industrial energy efficiency conference held in May 2005 in Ottawa. In March 2006, NRCan organized an energy efficiency workshop in Puebla, Mexico, in co-operation with CONAE.

Established in 2004, the Canada–Mexico Partnership (CMP) is designed to serve as a mechanism for identifying policies for facilitating co-operation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society. Sustainable housing has been identified as a priority theme under the CMP. Canada Mortgage and Housing Corporation (CMHC) has been charged

with chairing a working group on sustainable housing technologies under the CMP within the framework of a letter of intent (LOI) with CONAVI, the Mexico National Housing Agency. The LOI establishes the scope of the working group activities. NRCan participates as a member of this working group through the CANMET Energy Technology Centre.

In 2006, under the CMP, NRCan and CMHC facilitated meetings between Mexican builder-developers and Canadian photovoltaic (PV) and solar domestic hot water companies. In 2007, five PV units were installed in a residential development in Mexicali, Mexico, using a system designed by ICP, a Montréal company. The project will be used as a case study to provide the builder, state and utility with field data to assess the value of developing a business case for an incentive-based PV program for residential grid-connected PV energy supply in the region. In 2006, Mexican stakeholders also expressed interest in Canadian approaches to sustainable neighbourhood-scale projects, including standards for sustainable projects, decision-making tools and access to Canadian case studies. A workshop to facilitate this information exchange was conducted in Tijuana, Mexico, in 2007.

Innovative financing for renewable energy and energy-efficient projects is an ongoing theme under the CMP working group. Mexico is launching a "green mortgage" instrument, and government and industry stakeholders have expressed interest in learning more about financing instruments for renewable energy and energy efficiency features in housing. This theme remains an area of mutual interest.

United States

In September 2005, NRCan's OEE signed an MOU with the U.S. Environmental Protection Agency to share in the common goal of achieving greater energy efficiency and reducing carbon dioxide, particulate matter and oxides of nitrogen emissions through the work of their respective programs: ecoENERGY for Fleets (FleetSmart) and the SmartWay Transport Partnership. These two programs use a voluntary approach with the on-road freight sector to increase energy efficiency through training, education and reporting initiatives. They are working together to harmonize program efforts in Canada and the United States.

North America

In July 2007, energy ministers of Canada, the United States and Mexico signed a co-operation agreement on energy science and technology. The trilateral agreement provides a legal framework for R&D co-operation on new technologies in such areas as bioenergy, clean coal, carbon capture and storage, fuel cells, and electricity networks. This new agreement supersedes a previous U.S.–Canada MOU on energy R&D.

NRCan continues to participate with the United States and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency standards and co-operation on energy efficiency labelling programs. In 2007–2008, work under NAEWG primarily involved coordinating the energy sector commitment to the North American Security and Prosperity Initiative. In addition to ongoing standards and program collaboration, NAEWG initiatives were implemented to develop a North American approach to vehicle fuel efficiency and standby loss by electricity-using products. A workshop on energy efficiency was held in Mexico City on October 1–2, 2007, to promote trilateral collaboration on transportation.

APPENDIX 1

Natural Resource Canada's Efficiency and Alternative Energy Initiatives and Expenditures, 2007–2008

(millions of dollars)

Energy Efficiency and Alternative Transportation Fuels[1]	**$74.9**
ecoENERGY for Equipment	
ecoENERGY Retrofit – Homes	
ecoENERGY Retrofit – Small and Medium Organizations	
ecoENERGY Retrofit – Existing Buildings Initiative	
Federal Buildings Initiative	
ecoENERGY for Buildings and Houses	
ecoENERGY for Industry	
ecoENERGY for Personal Vehicles	
ecoENERGY for Fleets	
ecoENERGY for Biofuels	
Ethanol Expansion Program	
National Energy Use Database	
Energy Efficiency – Energy Science and Technology[2]	**$98.9**
Clean Energy Systems for Buildings and Communities	
Clean Electric Power Generation	
Clean Energy Systems for Industry	
Environmentally Sustainable Oil and Gas Development	
Clean Transportation Energy	
Sustainable Bioenegy	
Canadian Biomass Innovation Network	
Alternative Energy – Renewable Energy Sources	**$54.3**
ecoENERGY for Renewable Heat	
ecoENERGY for Renewable Power	
Wind Power Production Incentive[3]	
Initiative to Purchase Electricity From Emerging Rewewable Energy Sources[4]	
Total	**$228.1**

[1] The Energy Efficiency and Alternative Transportation Fuels total does not include the Sustainable Development Technology Canada – NextGen Biofuels Fund™. For details on this Fund, refer to the text box on page 61.

[2] Totals allocated for the Program of Energy Research and Development, Climate Change Technology and Innovation Research and Development, and ecoENERGY Technology Initiative in Chapter 4 are reflected in the relevant program entries.

[3] The Wind Power Production Incentive is fully committed, but incentives will be paid out to recipients until 2016–2017.

[4] The Initiative to Purchase Electricity From Emerging Rewewable Sources is fully committed, but incentives will be paid out until 2011–2012.

APPENDIX 2

Data Presented in the Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy-use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*. This report, however, uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 to 2005*.

FIGURE 1-1: Secondary Energy Use by Sector, 2005

Sector	Industrial	Transportation	Residential	Commercial/ Institutional	Agriculture	Total
Energy use (PJ)	3209	2502	1402	1153	209	8475
Percentage	0.379	0.295	0.165	0.136	0.025	1.000

FIGURE 1-2: GHG Emissions From Secondary Energy Use by Sector, 2005

Sector	Transportation	Industrial	Residential	Commerical/ Institutional	Agriculture	Total
GHG emissions (Mt)	177.5	164	73.8	65.3	14.4	495
Percentage	0.36	0.33	0.15	0.13	0.03	1.00

FIGURE 1-3: Energy Intensity and the Energy Efficiency Effect, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.97	0.91	0.89	0.87	0.84	0.85	0.85	0.84	0.81
Index of energy efficiency effect	1.00	0.98	0.97	0.96	0.96	0.92	0.93	0.91	0.89	0.87	0.87	0.86	0.87	0.88	0.86	0.84

FIGURE 1-4: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated secondary energy use without energy efficiency improvements	1.00	1.00	1.03	1.05	1.09	1.15	1.17	1.20	1.20	1.25	1.29	1.27	1.31	1.33	1.36	1.38
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18	1.22	1.23	1.22

FIGURE 1-5: Canadian Households by Type of Dwelling, 2005

Dwelling type	Number of households	Percentage
Single detached homes	7 083 709	56
Single attached homes	1 320 470	10
Apartments	3 936 757	31
Mobile homes	245 834	2
Total	**12 586 770**	**100**

FIGURE 1-6: Residential Energy Use by End-Use, 2005

Activity	Energy use (PJ)	Percentage
Space heating	846.1	60
Water heating	248.2	18
Appliances	203.0	14
Lighting	68.4	5
Space cooling	36.5	3
Total	**1402.2**	**100**

FIGURE 1-7: Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of households	1.00	1.03	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.23	1.25	1.27
Average floor space by household	1.00	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Energy intensity (GJ/household)	1.00	0.96	0.97	0.98	0.98	0.95	1.01	0.96	0.86	0.88	0.91	0.86	0.89	0.91	0.88	0.86

FIGURE 1-8: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.14	1.18	1.25	1.22	1.28	1.32	1.32	1.34
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.12	1.08	0.99	1.03	1.08	1.04	1.08	1.12	1.10	1.09

FIGURE 1-9: Annual Heating Consumption for Houses* Constructed to Different Standards

House type	Annual heating consumption (GJ)
R-2000 house	78.75
Model National Energy Code house (2002)	112.10
Typical new house (2002)	146.27
Typical existing house (1970)	216.81

* 198-m^2 one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 1-10: Average Energy Consumption of New Electric Appliances, 1990 and 2005 Models

Appliance	1990 (KWh/yr)	2005 (KWh/yr)
Freezers	714	386
Electric ranges	772	573
Refrigerators	956	469
Dishwashers	841	324
Clothes dryers	1103	904
Clothes washers	1218	444

FIGURE 1-11: Commercial/Institutional Energy Use by Activity Type*, 2005

Activity type	Energy use (PJ)	Percentage
Offices**	399.5	35
Retail trade	192.1	17
Educational services	158.9	14
Health care and social assistance	105.3	9
Accommodation and food services	86.3	7
Wholesale trade	64.1	6
Transportation and warehousing	54.0	5
Arts, entertainment and recreation	36.3	3
Information and cultural industries	27.6	2
Other services	21.1	2
Total	**1145.2**	**100**

* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 1-12: Commercial/Institutional Energy Use by Purpose, 2005

End use	Energy use (PJ)	Percent
Space heating	585.3	51
Auxiliary equipment	165.6	14
Lighting	108.0	9
Space cooling	99.6	9
Water heating	98.6	9
Auxiliary motors	88.1	8
Street lighting	7.9	1
Total	**1153.0**	**1.00**

FIGURE 1-13: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.14	1.16	1.20	1.20	1.17	1.22	1.26	1.26	1.34	1.36	1.36	1.42
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35	1.33

FIGURE 1-14: Industrial Energy Use by Subsector – Including Electricity-Related Emissions*, 2005

Subsector	Industrial Energy Use (%)	Energy use (PJ)
Pulp and paper	26	823.7
Mining	20	647.8
Other manufacturing**	17	539.6
Petroleum refining	11	360.6
Smelting and refining	8	264.7
Iron and steel	7	236.9
Chemicals	6	186.6
Other industries***	3	80.6
Cement	2	69.0
Total	**100**	**3209.4**

* The above subsectors reflect the current definitions in the Report on Energy Supply-demand in Canada.
** "Other manufacturing" comprises more than 20 manufacturing industries.
*** "Other industries" includes construction and forestry.

FIGURE 1-15: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005

Industry	Energy cost (%) of total production cost
Transportation equipment and manufacturing	0.86
Petroleum refining	2.47
Chemicals	12.79
Iron and steel	12.99
Pulp and paper	15.04
Aluminum	16.78
Cement	37.07

FIGURE 1-16: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.14	1.14	1.18	1.19	1.24	1.28	1.24	1.28	1.29	1.31	1.31
Actual energy use	1.00	1.08	1.11	1.10	1.08	1.11	1.15	1.10	1.16	1.20	1.20	1.18

FIGURE 1-17: Transportation Energy Use by Mode, 2005

	Energy use (PJ)	Percentage
Passenger light vehicle	1070.4	
Passenger aviation	251.5	
Passenger bus	51.8	
Passenger rail	2.5	
Passenger total	**1376.1**	**55.0**
Freight aviation	7.9	
Freight truck	833.0	
Freight marine	111.2	
Freight rail	76.4	
Freight total	**1028.3**	**41.1**
Off-road total	**97.4**	**3.9**
Total transportation energy use	**250.8**	**100.0**

FIGURE 1-18: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Passenger car	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.7	59.1	60.9	63.0	63.4	62.7	62.1	61.58	61.59
Passenger light truck	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.3	40.9	39.1	37.0	36.6	37.3	37.9	38.42	38.41

FIGURE 1-19: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.05	1.12	1.15	1.18	1.23	1.27	1.32	1.34	1.36	1.38	1.41	1.48	1.52
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31	1.33

FIGURE 1-20: Average Activity per Truck, 1990 to 2005 (tonne kilometres/truck)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium-and heavy-duty truck vehicle activity	105 742	98 658	103 459	117 687	133 653	142 910	141 219	163 975	162 926	175 266	178 269	198 998	197 396	202 326	219 262	236 677

FIGURE 1-21: Trucking Energy Intensity, 1990 to 2005 (megajoules/tonne kilometres)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium-and heavy-duty truck energy intensity	3.71	3.81	3.79	3.62	3.44	3.46	3.41	3.33	3.16	2.99	3.02	2.83	2.80	2.92	2.86	2.72

FIGURE 1-22: Shares of On-Road Transportation Fuel, 2005

Fuel type	Energy use (petajoules)	Percentage
Electricity	3.5	0.18
Natural gas	1.9	0.10
Motor gasoline	1280.1	65.18
Diesel	659.2	33.56
Liquefied petroleum gas	10.3	0.52
Renewable fuels	9.1	0.46
Total	**1964.1**	**100.00**

FIGURE 2-1: Volume of Monthly Import Documents

Month	Paper	Electronic
Apr. 07	2 677	54 217
May 07	2 639	62 432
Jun. 07	2 480	66 194
Jul. 07	1 959	62 462
Aug. 07	2 436	68 386
Sep. 07	1 570	68 537
Oct. 07	864	85 151
Nov. 07	253	86 365
Dec. 07	100	83 720
Jan. 08	175	95 602
Feb. 08	152	93 899
Mar. 08	36	100 135
Total	**15 341**	**927 100**

FIGURE 2-4: ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005

Appliance	Model Year						
	1999	2000	2001	2002	2003	2004	2005
Dishwashers	0.56	1.57	9.66	29.77	56.5	80.95	90.8
Refrigerators	..	..	11.4	22.26	40.68	34.16	37.6
Washers	1.93	2.24	9.24	22.07	30.55	36.16	45.9

FIGURE 2-5: ENERGY STAR Awareness Levels in Canada, 2005

	Percent
Aware – non-aided	36
Aware – aided	80

FIGURE 3-1: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2007*	Average
Energy use pre-renovation (GJ)	272	205	189	177	179	168	157	195
Actual energy savings after renovations (GJ)	89	55	44	41	38	32	39	48

* Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

FIGURE 3-2: Number of Eligible R-2000 Housing Starts, 1990 to 2007

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Number of R-2000 houses	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	583	500	439	483

FIGURE 3-3: CIPEC Energy Intensity Index, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.91	0.92	0.94	0.91	0.90

FIGURE 3-4: Industrial Dollars to $ense Participants, pre-2000 to 2007

Fiscal year	Pre-2000	2001	2002	2003	2004	2005	2006	2007
Number of industrial workshop participants	748	408	353	481	880	1027	1290	1230

FIGURE 3-5: New Vehicle Fuel Efficiency Labelling

Year	On lot	In showroom
1999	64	47
2001	77	56
2005	78	61
2007	78	56

FIGURE 3-6: Company Average Fuel Consumption (CAFC) Versus Canadian Voluntary Standards, 1990 to 2006*

Model year	Truck standard (11.4 L/100 km)	Trucks CAFC	Car standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.3	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.4
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.6	8.6	7.5
2005	11.4	10.6	8.6	7.4
2006	11.4	10.2	8.6	7.0

*2002–2006 data are estimates.

FIGURE 5-1: Canadian Wind Power Capacity, 1993 to 2006

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wind power capacity (MW)	1	22	23	23	24	27	127	139	215	233	326	445	686	1459

Natural Resources Canada's Office of Energy Efficiency

Leading Canadians to Energy Efficiency at Home, at Work and on the Road

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Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2008–2009

Canada

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Publishing by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*
pour l'année financière 2008–2009

Cat. No. M141-10/2009E (Print)
ISBN 978-1-100-14494-8

Cat. No. M141-10/2009E-PDF (Electronic)
ISBN 978-1-100-14495-5

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Minister's Foreword

I am pleased to introduce the 2008/2009 Report to Parliament on Improving Energy Performance in Canada.

This government is committed to achieving environmental and economic benefits for all Canadians. That is why our government has invested $4.1 billion in our ecoENERGY initiatives to improve energy efficiency and enhance clean energy technologies in Canada.

Our government has taken strategic action to respond to the global economic recession through a suite of measures announced in Canada's Economic Action Plan. In the Speech from the Throne, the government committed to reviewing our energy-efficiency and emissions-reductions programs to ensure they continue to be an effective and efficient use of Canadian tax dollars.

Our government has also amended Canada's *Energy Efficiency Act* to make it more effective by broadening and clarifying its scope. Regulations made under the Act have been amended a number of times, most recently, in 2008 to expand the list of products covered by the Act and enhance standards for some products already in place. Amendments to the *Energy Efficiency Act* and the *Energy Efficiency Regulations* ensure that Canadians continue to enjoy the economic and environmental benefits of living in a country that is among the world leaders in energy efficiency.

In fall 2009, some of my officials met with key stakeholders to discuss strategies for building on our success. Our government is committed to collaborating with senior decision-makers from government, industry, non-government organizations and academia to advance our leadership in clean energy while continuing to promote energy efficiency.

Canada has made significant improvements in the efficiency of its energy use in all sectors of its economy and continues to make progress with support from Natural Resources Canada's energy efficiency programs. As we move forward, we will continue to pursue innovative technologies and program approaches for improving energy use.

The Honourable Christian Paradis, P.C., M.P.
(Mégantic - L'Érable)
Minister of Natural Resources

Executive Summary

Canadians spent approximately $155 billion in 2006 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

The two general types of energy use are primary and secondary. Primary use represents Canada's total consumption, including energy required to transform one energy form to another – such as coal to electricity – and energy required to deliver energy to consumers. Secondary use is energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2006, the latest year for which figures are available, primary energy use increased by 26 percent.
- In 2006, secondary use accounted for 69 percent of primary energy use and produced 69 percent (478 megatonnes [Mt]) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without the energy efficiency improvements made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumed the most energy, accounting for 39 percent of total secondary energy use in 2006. Transportation was second (30 percent), followed by residential (16 percent), commercial/institutional (13 percent) and agriculture (2.5 percent).

Promoting Energy Efficiency

Natural Resources Canada (NRCan) promotes energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan uses a broad range of policy instruments, including leadership, information, voluntary initiatives, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the terms. It is important to understand this difference when comparing Canada with other countries.

Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

Energy intensity is the amount of energy use per unit of activity. Examples of activity measures in this publication are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic product. Energy intensity is a broader measure, capturing not only energy efficiency but also other impacts on energy consumption, such as weather variations, market behaviour and changes in the structure of the economy.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors. However, this growth would have been much greater without improvements in energy efficiency.

As reported in Chapter 1, energy efficiency improvements made between 1990 and 2006 are estimated to have reduced GHG emissions by almost 59.6 Mt and decreased energy expenditures by $20.7 billion in 2006.

Between 1990 and 2006, the residential sector recorded a 26.1 percent improvement in energy efficiency. The figures for the transportation (18.2 percent), industrial (9 percent) and commercial/institutional (14 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce their energy bills and achieve important environmental goals. Over the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

Canada is a world leader in the production of renewable energy, with almost 16 percent of its primary energy supply coming from renewable sources in 2007.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of co-operative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector and highlights NRCan's efficiency and alternative energy (EAE) programs and lists their key achievements for the 2008–2009 fiscal year. Program entries for market transformation programs also include quantitative performance indicators in graph or table format. A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Introduction

NATURAL RESOURCES CANADA'S EFFICIENCY AND ALTERNATIVE ENERGY PROGRAMS

According to the International Energy Agency, if energy efficiency policies had not been introduced 30 years ago, today's worldwide energy consumption would be 50 percent higher.[1]

Gains in energy efficiency have substantial benefits for society, the economy and the environment. Energy efficiency can add to the global security of energy supplies by reducing the need for energy. It saves consumers and businesses money by decreasing their energy bills without disruptions to their daily routine, and it can increase access to energy services by reducing their effective cost.

In particular, greater energy efficiency is used as a strategy to reduce carbon dioxide and other greenhouse gases (GHGs) and thereby help reduce the effects of climate change.

Natural Resources Canada (NRCan) emphasizes the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as ways to reduce GHG emissions and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2008–2009 is in Appendix 1.

These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by the following:

- the Office of Energy Efficiency (OEE), which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- CanmetENERGY and the CANMET Mineral Technology Branch, which deliver EAE research, development and demonstration (R,D&D) initiatives
- the Office of Energy Research and Development, which coordinates NRCan's energy research and development planning and fund allocations
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and co-operation with stakeholders, such as other levels of government, the private sector and nongovernmental organizations.

[1] International Energy Agency, *Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency*, 2007.

With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels and in increasing the energy efficiency of energy production.

POLICY INSTRUMENTS

NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research, development and demonstration

Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations. Regulations primarily establish performance and labelling requirements for energy-using products and for doors and windows that are imported or shipped across provincial borders.

Financial Incentives

NRCan uses financial incentives to encourage end-users of energy to adopt energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants, natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods ranging from broad distribution to individual consultations with clients. This increases awareness of the environmental impact of energy use and encourages consumers to become more energy efficient and make greater use of alternative energy sources.

One particular outreach program targets youth as the energy consumers of the future and undertakes joint initiatives in the education sector. Other information activities include publications, exhibits, advertising, toll-free telephone lines, conferences, Web sites, workshops, training, building design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan voluntarily to set and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are major factors in energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, commitments to develop energy efficiency improvement targets and action plans. NRCan provides support to assist and stimulate action by companies and institutions on energy efficiency, including developing standards, educational material and training.

Research, Development and Demonstration

Ongoing improvement in energy efficiency is contingent on improvements and innovations in technology. NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R,D&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking research in its own laboratories and contracting research activities to other organizations. These initiatives are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

FIGURE INT-1

Moving the Market

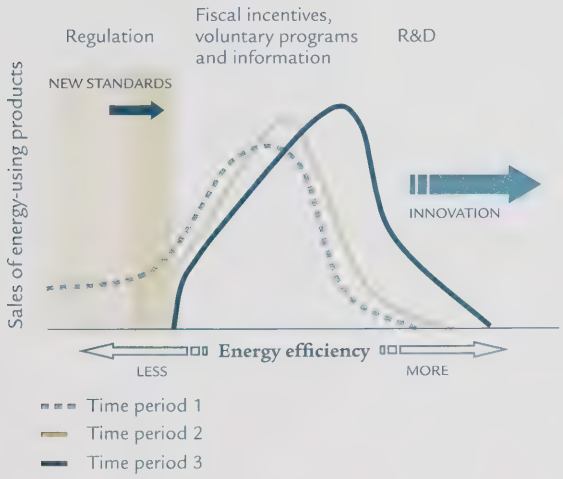


Figure INT-1 shows how these policy instruments work together to increase energy efficiency, that is, how they help to reduce the amount of energy required to complete a task or obtain a certain level of service. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information activities increase the number of people and organizations taking advantage of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving higher levels of efficiency in a particular type of energy use.

MEASURING PROGRESS

The primary goal of NRCan's EAE initiatives is to change energy consumption patterns and thereby generate environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness. NRCan monitors and tracks the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and government and non-government programs.

Because program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress toward a market outcome, serves as an indicator of program effectiveness.

An example of a program outcome leading to a market outcome is a householder's purchase of a more energy-efficient appliance, resulting in reduced use of electricity. Depending on what source of electricity is involved and how the utility changes its electricity-generating methods to meet the change in demand resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

DATA COLLECTION AND ANALYSIS

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the Department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support its analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities. However, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of energy use in the transportation, industrial, commercial/institutional and residential sectors. The surveys gather information about the stocks and characteristics of energy-using equipment and buildings, observing Canadians' behaviour with respect to energy use and monitoring the adoption of new technologies in the marketplace.

In 2008–2009, analysis of the commercial and residential sectors was undertaken for reference year 2007. These analyses form the basis of reports explaining how and where energy is used in each of these sectors (Commercial and Institutional Consumption of Energy Survey [CICES], Survey of Household Energy Use [SHEU]). Data on the transportation and industrial sectors continue to be collected on a quarterly and annual basis, respectively.

The NEUD initiative also produces a comprehensive energy use database with accompanying publications to explain Canada's overall energy use and energy efficiency trends. All NEUD initiative reports are available to the public, free of charge, both in hard copy and online at oee.nrcan.gc.ca/statistics.

The NEUD initiative also contributes to the development of energy end-use data and analysis centres (DACs) across Canada. Three DACs have been set up: the transportation centre at Université Laval in Québec, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta. The DACs are mandated to improve the accessibility and comparability of existing data about trends in energy consumption and their impact on environmental quality.

GHG EMISSIONS AND CLIMATE CHANGE

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere in addition to naturally occurring emissions. GHGs are composed of several gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of co-operation among all nations.

IN THIS REPORT

This sixteenth annual *Report to Parliament* focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada for the residential, commercial, industrial, transportation and renewable energy sectors are discussed in Chapter 1.

Chapter 2 discusses equipment regulations under the *Energy Efficiency Act* and equipment-labelling activities. Chapter 3 describes the suite of ecoENERGY and related programs and lists key 2008–2009 achievements. Chapter 4 explains energy S&T programs and achievements related to energy efficiency and the continued integration of renewable sources. Chapter 5 outlines NRCan's involvement with renewable energy sources and use. The sixth and final chapter describes domestic and international co-operation in EAE.

Appendix 1 contains information about NRCan's EAE expenditures. Appendix 2 contains detailed information about the figure data presented in this report. Calculations of the estimated GHG savings in this report are based on Environment Canada's standardized emissions factors as described in its publication *Canada's Greenhouse Gas Inventory*. The emissions factor for electricity was based on the provincially weighted average of marginal fuel sources across the country.

CHAPTER 1

Trends in Energy Use

INTRODUCTION

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also fosters the development of industries with a particularly strong energy demand.

Canadians spent about $155 billion in 2006 on energy to heat and cool their homes and offices and to operate their appliances, vehicles and industrial processes. This amount represented 14 percent of the country's gross domestic product (GDP).[2]

ENERGY USE AND GREENHOUSE GAS EMISSIONS

Energy use is of two general types: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use represents the total requirements for all users of energy, including secondary energy use. In Canada, the increase in primary energy use reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 26 percent between 1990 and 2006, from 9740 petajoules[3] (PJ) to 12 257 PJ.

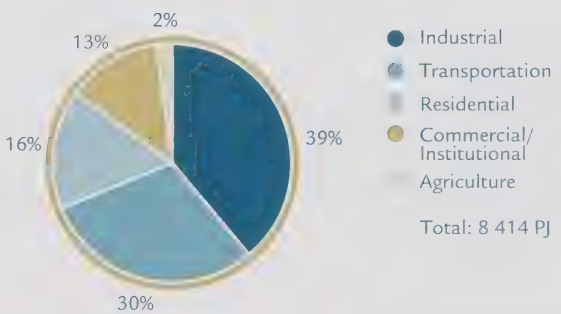
Secondary energy use accounted for 69 percent of primary energy use in 2006, or 8413 PJ. It was responsible for 69 percent (478 megatonnes [Mt]) of total greenhouse gas (GHG) emissions in Canada, including indirect emissions – those produced by electric utilities to meet end-use electrical demand.

From 1990 to 2006, secondary energy use increased by 21 percent. However, since 2005 there has been a slight downward trend. Also, from 1990 to 2006, the Canadian population grew 18 percent, and the GDP increased 55 percent. Thus energy use grew less rapidly than the economy but more rapidly than the population.

As demonstrated in Figure 1-1, the industrial sector was the largest energy user, accounting for 39 percent of total secondary energy use in 2006. The transportation sector was the second largest energy user at 30 percent, followed by the residential sector at 16 percent, the commercial/institutional sector at 13 percent and the agricultural sector at 2 percent.

FIGURE 1-1

Secondary Energy Use by Sector, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0

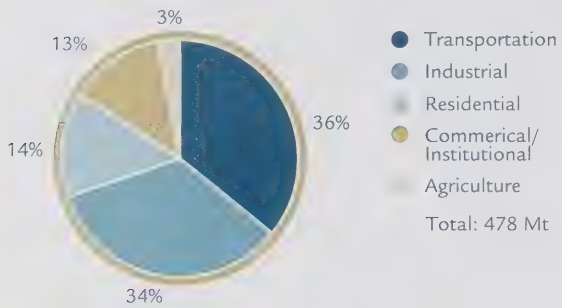
[2] Data in this chapter are presented for 1990 2006. Readers are encouraged to consult the Office of Energy Efficiency Web site to view data updates as they become available.

[3] One petajoule equals 1×10^{15} joules.

Figure 1-2 illustrates the distribution of GHG emissions by sector. This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 accounts for most of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and emissions that are attributable indirectly to electricity generation, unless otherwise specified.

FIGURE 1-2

GHG Emissions From Secondary Energy Use by Sector, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0

ENERGY INTENSITY AND ENERGY EFFICIENCY

The term "energy intensity" refers to the amount of energy use per unit of activity. Energy intensity is sometimes used as a proxy for energy efficiency because it is a simple calculation for which data are readily available. However, this measure can be misleading because, in addition to pure energy efficiency, intensity captures the impact of other factors that influence energy demand, such as weather variations and changes in the structure of the economy.

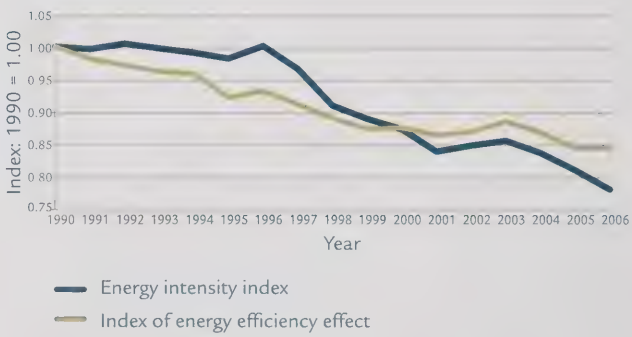
Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique – the Log-Mean Divisia Index I methodology – to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-3 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency from 1990 to 2006. As illustrated, Canada's energy intensity and efficiency improved over this period. The reduction in energy intensity reflects an overall improvement in energy efficiency or how effectively energy is being used in producing one unit of GDP. At the same time, the improvement in energy efficiency indicates how effectively energy is being used to provide a certain level of service or output.

FIGURE 1-3

Energy Intensity and the Energy Efficiency Effect, 1990 to 2006



Source: Natural Resources Canada, Residential, Commercial/Institutional, Transportation, Industrial End-Use Models, Ottawa, 2008.

As illustrated in Figure 1-3, intensity underestimates the efficiency effect in Canada in the early 1990s and overestimates its impact in the latter part of the period. Before 1998, intensity improvements appear to be modest because colder weather (1992–1997) and a shift toward more energy-intensive industries (1990–1996) masked energy efficiency progress. In 2000, the intensity index dipped below the index for the energy efficiency effect. A switch to less energy-intensive industries, which began in the mid-1990s, combined with energy efficiency improvements accelerated the decline in energy intensity.

TRENDS IN ENERGY EFFICIENCY

NRCan regularly publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use and GHG emissions and the contributions of the following key factors to these changes (see Table 1-1):

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.

TABLE 1-1

Explanation of Changes in Secondary Energy Use, 1990 to 2006

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total*	Change (%)
1990 energy use (PJ)	1286.2	867.0	2721.8	1877.9	6952.1	
2006 energy use (PJ)	1347.3	1092.6	3270.6	2492.0	8413.3	
Change in energy use (PJ)	61.1	225.6	548.8	614.1	1461.2	21.0
Explanatory factor (change due to)						
Activity	373.5	273.8	1197.2	750.4	2585.4	37.2
Weather	61.6	23.3	n/a	n/a	84.9	1.2
Structure	7.4	1.4	392.4	186.8	210.8	3.0
Service level	76.9	93.4	n/a	n/a	170.3	2.4
Energy efficiency	-335.1	-116.3	-347.3	255.9	1049.6	15.1
Other factors					50.8	0.7

*Total also includes energy use for agriculture.

Sources: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0
oee.nrcan.gc.ca/corporate/statistics/neud/dpa/analysis_ca.cfm?attr=0

- **Service level** refers to the penetration rate of electrical devices and equipment, for example, the use of auxiliary equipment in commercial/institutional buildings and appliances in homes or the amount of floor space cooled.

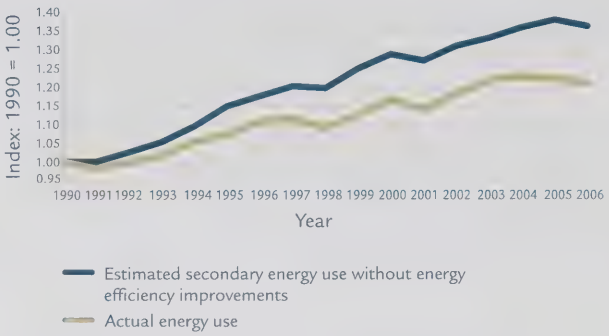
- **Energy efficiency** effect indicates how effectively energy is being used, for example, the degree to which less energy is being used to provide the same level of energy service. Energy efficiency gains occur primarily with improvements in technology or processes. An example of such an improvement would be replacing incandescent lights with compact fluorescent lamps.

In this report, changes in energy efficiency are the net result after allowing for changes in energy use due to activity, weather, structure and service level. However, other factors, such as individual consumer choice, may affect energy use and are not captured by the above standardized factors. The effects of activity, weather, structure and service level may overstate or understate the "actual" change in energy use and energy efficiency improvements.

Between 1990 and 2006, secondary energy use in Canada increased from 6952 to 8413 PJ. Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an energy increase of 36 percent. However, as a result of a 15 percent (1049 PJ) improvement in energy efficiency,[4] actual secondary energy use increased by only 21 percent (to 8413 PJ). This improvement in energy efficiency is estimated to have reduced GHG emissions by 59.6 Mt and decreased energy expenditures by $20.7 billion in 2006. The change in energy use between 1990 and 2006, actual and without energy efficiency improvements, is shown in Figure 1-4.

FIGURE 1-4

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/analysis_ca.cfm?attr=0

TRENDS IN RENEWABLE ENERGY

Canada is a leader in the production of renewable energy, with over 16 percent of its primary energy supply coming from renewable sources in 2007. Although renewable energy is often associated with electricity, renewable energy sources also produce thermal energy (heat) and transportation fuels. Renewable energy sources in Canada include inland and ocean water, wind, solar, geothermal and biomass.

Canada has a significant renewable electricity supply due primarily to the widespread use of hydroelectricity. In 2007, 59 percent of Canada's electricity generation was provided by conventional and small hydroelectric plants, which generated more than 364 terawatt hours (TWh) of electricity, up from 349 TWh in 2006. Small hydro plants (less than 50 megawatts [MW]), with installed generating capacity of 3301 MW, provided about 2 percent of the total electricity generation in Canada.

Several provinces are taking steps to support the development of the next generation of ocean renewable energy technologies, which use waves, ocean currents and tides to generate electricity.

The Fundy Ocean Resource Centre for Energy, a technology demonstration facility, will test three

[4] Based on the OEE Index.

technologies with a total capacity of 4 MW by 2010. Wave and tidal-current technologies are also being tested off the coast of British Columbia, and a commercial facility for generating electricity may be feasible within the next decade.

Although technical, regulatory and financial challenges remain, ocean energy has the potential to provide Canada with an abundant source of renewable energy.

Non-hydro renewable sources accounted for an estimated 2 percent of Canada's electricity generation. With 1578 MW of installed capacity in 2007, biomass (waste and virgin biomass and landfill gas) is the main non-hydro renewable energy source in Canada.

However, wind energy is growing rapidly, with an increase in capacity from 139 MW in 2000 to 2369 MW in 2008. Wind power may soon be moving to the offshore, with large projects planned on submerged lands off the coast of British Columbia and in the Great Lakes.

Solar photovoltaic energy also experienced high rates of capacity growth – about 20 percent annually between 1993 and 2006 – although it started from a low baseline. In 2007, 25.8 MW of solar photovoltaic systems were installed in Canada, representing an increase of 5.3 MW from the previous year.

As described in Chapter 5, NRCan is carrying out two initiatives, ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat, to increase the use of renewable energy in Canada.

TRENDS IN RESIDENTIAL SECTOR

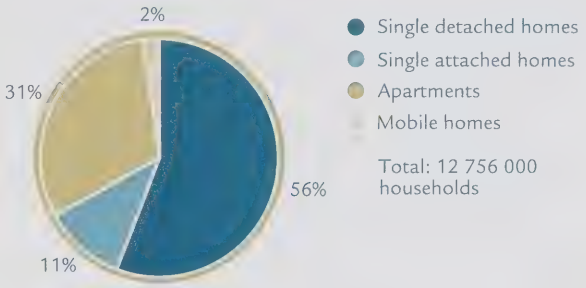
Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling; water heating; and the operation of appliances, electronic equipment and lights. In 2006, this sector accounted for 16 percent (1347 PJ) of secondary energy use and 14.5 percent (69.6 Mt) of GHGs emitted in Canada, continuing a downward trend in energy use and emissions since 2004.

Most dwellings in Canada are single detached houses. The next largest type of dwelling is apartments, followed by single attached dwellings and mobile homes (see Figure 1-5). The OEE's ecoENERGY Retrofit – Homes and ecoENERGY for Buildings and Houses programs aim to improve the energy efficiency of single detached and attached houses.

FIGURE 1-5

Canadian Households by Type of Dwelling, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/analysis_ca.cfm?attr=0

Between 1990 and 2006, residential energy use increased by 4.8 percent, or 61 PJ. However, since 2004, residential energy use has been decreasing at a significant rate.

For the same period between 1990 and 2006, GHG emissions increased by only 0.4 percent, mainly due to the significant reductions in GHG emissions that occurred since 2004.

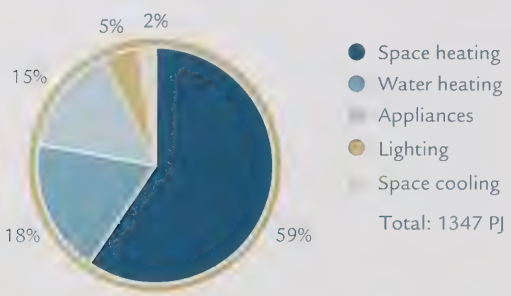
GHG intensity decreased 21.5 percent despite the average household operating more appliances, becoming larger and increasing its use of space cooling. Space and water heating constituted 77.3 percent of residential energy use (which exhibited a small drop in space heating energy use), followed by operating appliances, lighting and space cooling (see Figure 1-6).

Five main factors influenced residential energy use between 1990 and 2006 – activity, weather, structure, service level and energy efficiency effect:

- Activity – The increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 29.0 percent (373.5 PJ).
- Weather – The winter in 2006 was much warmer compared with the winter in 1990, as was the summer (yet cooler than in 2005). The result was a 4.8 percent (61.6 PJ) decrease in energy use in 2006.
- Structure – The relative share of households by dwelling type (single detached, apartments, etc.) changed over the period. This change contributed to an increase in energy use of 0.6 percent (7.4 PJ) in 2006.
- Service level – The increased market penetration rate of appliances and increased floor space cooled by space-cooling units increased energy use by 6.0 percent (76.9 PJ).
- Energy efficiency effect – Improvements to the thermal envelope of houses and to the efficiency of residential appliances and space- and water-heating equipment led to an overall gain in energy efficiency and decreased energy use by 26.1 percent (335.1 PJ).

FIGURE 1-6

Residential Energy Use by End-Use, 2006



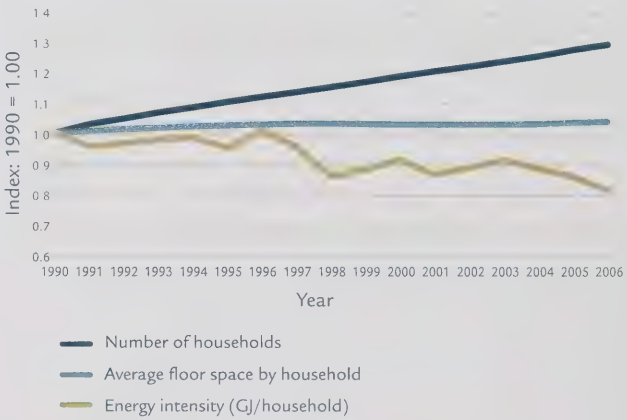
Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_res_ca.cfm?attr=0

Growth in residential energy use was driven in large part by growth in activity. This growth in activity – specifically, growth in total floor space and number of households – was due to the increase in the average size of newly constructed houses, the rising population and the trend toward fewer individuals per household (see Figure 1-7).

These increases were partially offset by significant improvements in energy efficiency. Structural changes also contributed to growth in energy use, because more individuals tended to live in single detached homes and the relative share of individuals living in apartments declined. Similarly, service level increased energy demand, because more Canadians cooled their homes during the summer months in 2006 than in 1990 and Canadians operated more appliances in 2006 than they did in 1990.

FIGURE 1-7

Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/analysis_ca.cfm?attr=0

Energy Efficiency

The change in residential energy use between 1990 and 2006 and the estimated energy savings due to energy efficiency measures are shown in Figure 1-8.

Overall energy efficiency upgrades – including improvements to the thermal envelope (insulations, windows, etc.) and more energy-efficient appliances,

furnaces and lighting – resulted in significant monetary savings for each Canadian household.

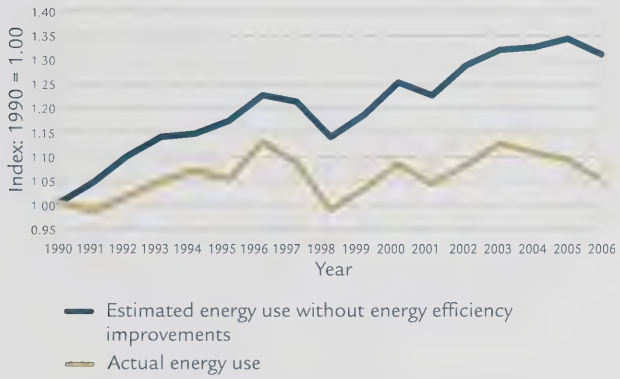
The 26.1 percent improvement in energy efficiency between 1990 and 2006 translated into $6.6 billion in energy savings in 2006.

Figure 1-9 shows how energy consumption differs for houses built in different periods, reflecting improvements in building construction.

Figure 1-10 shows how average energy consumption of new appliances has improved, by comparing 1990 and 2006 models.

FIGURE 1-8

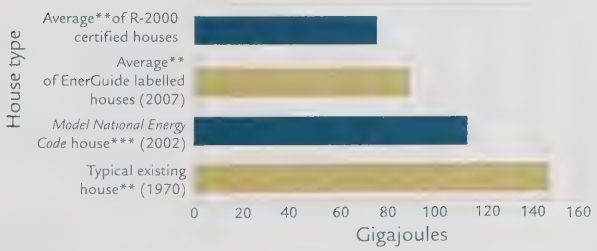
Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006



Source: Natural Resources Canada, Residential End-Use Model, Ottawa, 2008.

FIGURE 1-9

Annual Heating* Consumption for Houses Constructed to Different Standards



*DHW and space heating

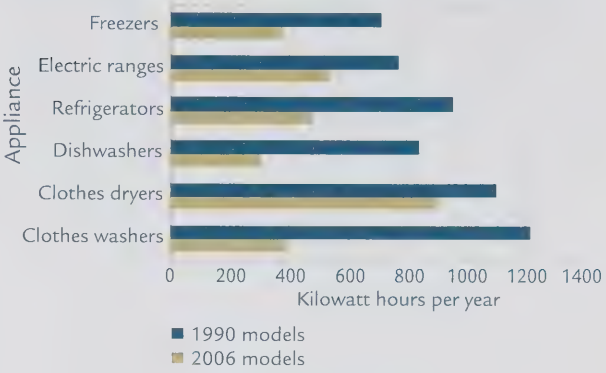
**National average

***198-m^2, two-storey, single detached house heated with natural gas in Ottawa, Ontario

Source: NRCan national housing database and internal data.

FIGURE 1-10

Average Energy Consumption of New Electric Appliances, 1990 and 2006 Models



Source: Natural Resources Canada, Residential End-Use Model, Ottawa, 2008.

NRCan carries out the following initiatives to increase energy efficiency in the residential sector:

- ecoENERGY Retrofit – Homes
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN COMMERCIAL/ INSTITUTIONAL SECTOR

Energy Use and Greenhouse Gas Emissions

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, operation of auxiliary equipment, space cooling, lighting, motive power for such services as pumping and ventilation in buildings, and street lighting.

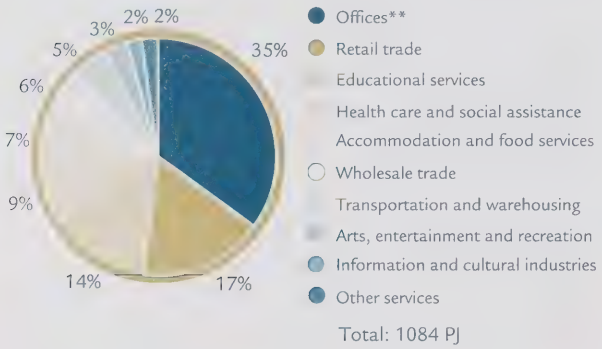
In 2006, the commercial/institutional sector accounted for 13 percent (1093 PJ) of secondary energy use and 12.6 percent (60.4 Mt) of GHG emissions in Canada. Between 1990 and 2006, commercial/institutional energy use (including street lighting) increased by 26 percent, or 226 PJ.

However, GHG emissions from the sector rose by 27 percent in the same period. The increase in use of GHG-intensive fuels, such as heavy oil and light fuel oil, explains why GHG emissions grew at a faster pace than energy use.

To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 1-11). In 2006, offices accounted for 35 percent of the sector's energy demand. Retail trade, educational services, health care and social assistance, and accommodation and food services accounted for another 47 percent of that demand.

FIGURE 1-11

Commercial/Institutional Energy Use by Activity Type,* 2006



* Excludes street lighting.

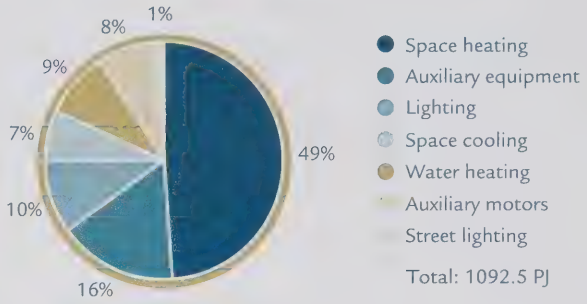
**"Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_res_ca.cfm?attr=0

Energy is used for seven purposes in commercial/institutional activities. As illustrated in Figure 1-12, in 2006, the largest of these was space heating, which accounted for almost half of the energy use in the sector. The remaining six uses of energy accounted for between 1 and 16 percent of energy demand in the sector.

FIGURE 1-12

Commercial/Institutional Energy Use by Purpose, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_res_ca.cfm?attr=0

Five main factors influenced commercial/institutional energy use between 1990 and 2006 – activity, weather, structure, service level and energy efficiency effect:

- Activity – More floor space increased energy use in the sector by 28 percent and caused a 274-PJ increase in energy use.
- Weather – The winter of 2006 was warmer compared with the winter of 1990, as was the summer. The net result was a 3 percent decrease in energy use (23 PJ) for space heating and cooling.
- Structure – The impact of structural changes (mix of building types) was marginal but produced a decrease of 1.4 PJ in energy use.
- Service level – An increase in the service level of auxiliary equipment (e.g. computers, photocopiers) and space cooling caused an 11 percent increase in energy use (93 PJ).
- Energy efficiency effect – A 14 percent improvement in energy efficiency saved 116 PJ of energy.

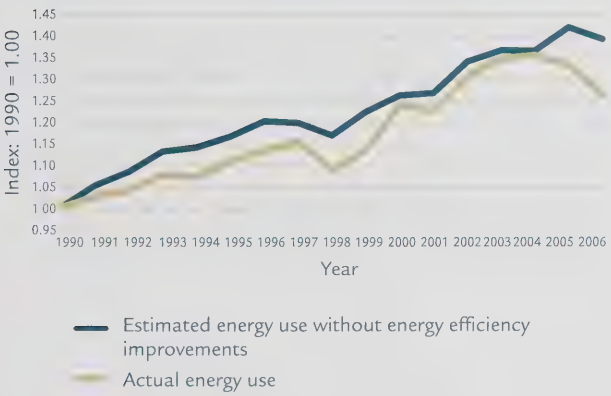
Energy Efficiency

Gains in energy efficiency were made through improvements to the thermal envelope of buildings (insulation, windows, etc.) and increased efficiency of energy-consuming items, such as furnaces, auxiliary equipment and lighting, which slowed the rate of increase in energy use. Without improvements in energy efficiency, energy use in the commercial/institutional sector would have increased by 39 percent. However, between 1990 and 2006, actual energy use increased by only 26 percent, resulting in energy savings of $2.5 billion in 2006.

During this period, energy efficiency in the commercial/institutional sector improved by 14 percent. The change in energy use between 1990 and 2006, as well as the estimated energy savings due to improvements in energy efficiency, are shown in Figure 1-13.

FIGURE 1-13

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006



Source: Natural Resources Canada, Commercial/Institutional End-Use Model, Ottawa, 2008.

NRCan carries out the following initiatives to increase energy efficiency in the commercial/institutional sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (See Chapter 2)

TRENDS IN INDUSTRIAL SECTOR

Energy Use and Greenhouse Gas Emissions

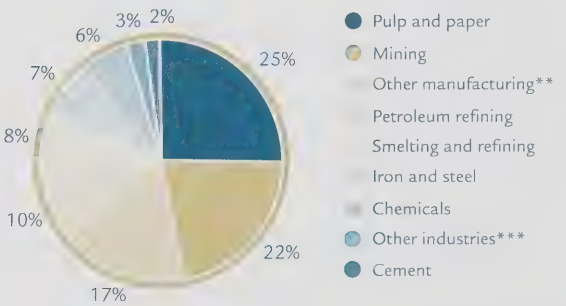
The industrial sector includes all manufacturing industries, all mining activities (including oil and gas extraction), forestry and construction. However, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power and to produce heat or generate steam.

Overall, industrial energy demand in 2006 accounted for 39 percent (3271 PJ) of secondary energy use and 34 percent (162 Mt) of GHG emissions (including electricity-related emissions). Between 1990 and 2006, actual industrial energy use increased by 20 percent (549 PJ). This increase was caused by a 44 percent increase in industrial activity, measured as a combination of physical units of production, gross output and GDP.

In the industrial sector, energy was consumed primarily in pulp and paper production, mining, petroleum refining, and in the smelting and refining industries. Pulp and paper production alone accounted for 25 percent of total industrial energy demand in 2006 (see Figure 1-14).

FIGURE 1-14

Industrial Energy Use by Subsector – Including Electricity-Related Emissions,* 2006



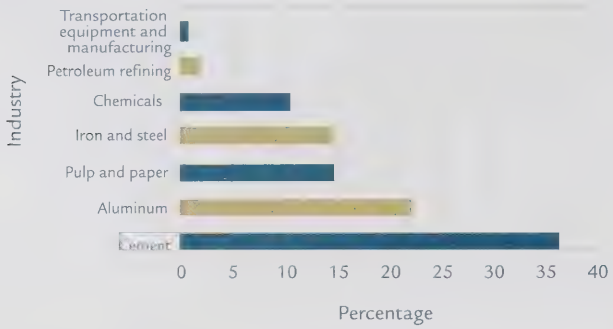
*The above subsectors reflect the current definitions in the *Report on Energy Supply and Demand in Canada*.
**"Other manufacturing" comprises more than 20 manufacturing industries.
***"Other industries" includes construction and forestry.

Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_agg_ca.cfm

In most industries, energy purchases accounted for only a small portion of total expenditures. However, for some relatively energy-intensive industries – cement, aluminium, pulp and paper, iron and steel, and chemicals – this share was higher than 11 percent (see Figure 1-15). For cement, in particular, the share was 37 percent.

FIGURE 1-15

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2006



Source: Statistics Canada, CANSIM Table 301-0006.

Between 1990 and 2006, industrial GHG emissions, including electricity-related emissions, increased by 14 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 9 percent. Most of this increase in direct GHG emissions occurred in the upstream oil and gas industry. The mining, manufacturing and construction industries, however, achieved a 10 percent decrease in GHG emissions.

Three main factors influenced industrial energy use between 1990 and 2006 – activity, structure and energy efficiency effect:

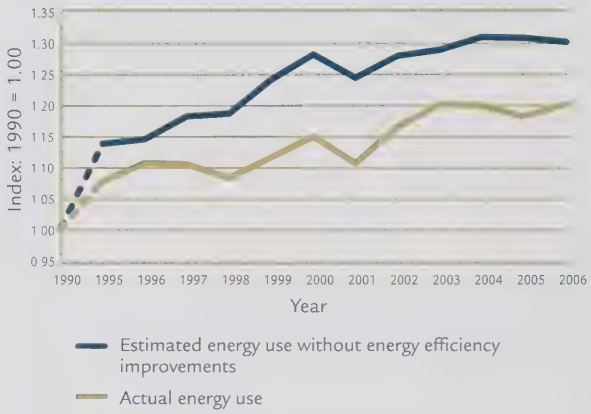
- Activity – Increases in the physical units of production, gross output and GDP contributed to a 44 percent increase in industrial activity, resulting in an 1197.2-PJ increase in energy use.
- Structure – The shift in the mix of activity toward less energy-intensive industries caused a 392-PJ decrease in energy use.
- Energy efficiency effect – Owing to a 9 percent improvement in energy efficiency, the industrial sector avoided 256 PJ of energy use.

Energy Efficiency

The change in energy use between 1990 and 2006 and the estimated energy savings attributed to energy efficiency are shown in Figure 1-16.

FIGURE 1-16

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006



Source: Natural Resources Canada, Industrial End-Use Models, Ottawa, 2008.

Energy efficiency improvements in the form of more efficient capital and management practices are important factors in managing energy use and decreasing energy intensity.

Between 1990 and 2006, energy efficiency in the industrial sector improved 9 percent. In 2006, Canadian industry saved $2.9 billion in energy costs. This gain was largely the result of improvements in energy intensity, representing the shift toward less energy-intensive activities. However, the energy savings from the energy efficiency improvements made by some industries were offset by increases in consumption by the upstream oil and gas, fertilizer and forestry subsectors.

NRCan carries out the following initiatives to increase energy efficiency in the industrial sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Industry
- Clean Energy Systems for Industry
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN TRANSPORTATION

Energy Use and Greenhouse Gas Emissions

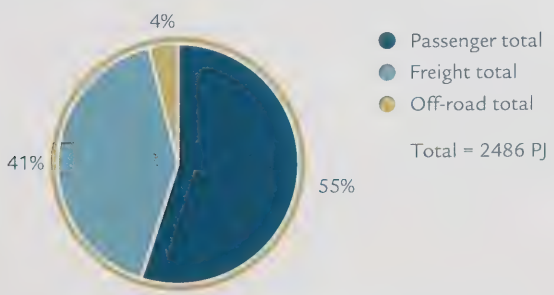
In 2006, transportation was second to the industrial sector in terms of energy use, accounting for 30 percent (2492 PJ) of Canada's total secondary energy use and the largest portion of Canadian end-use GHG emissions at 36 percent (172.4 Mt).

Transportation accounts for a greater share of GHG emissions because the main fuels used by the sector are more GHG-intensive than those used in other sectors of the economy.

The transportation sector consists of three subsectors: passenger, freight and off-road. In 2006, passenger and freight transportation accounted for 55 percent and 41 percent of transportation energy use respectively, while off-road represented only 4 percent (see Figure 1-17). Owing to limitations in the available data and the small percentage it accounts for, the off-road subsector is not analysed in further detail.

FIGURE 1-17

Transportation Energy Use by Mode, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tran_ca.cfm?attr=0

The passenger subsector has three modes: road, rail and air. The freight subsector, as defined by NRCan, is composed of road, rail, air and marine modes. Within these two subsectors, road transport uses the most energy, accounting for 78 percent of total transportation energy use in 2006.

All of NRCan's transportation energy use programs focus on the energy used in road transportation. Total transportation energy use increased by 33 percent (614 PJ) between 1990 and 2006. Within the transportation sector, passenger transportation energy use increased by 16 percent (186 PJ), while freight transportation energy use increased by 60 percent (382 PJ).

Three main factors influenced transportation energy use between 1990 and 2006 – activity, structure and energy efficiency effect:

- Activity – Increases in population, air transportation and economic activity (e.g. free trade) caused increased transportation activity.[5] The change in activity increased transportation energy use by 39 percent (741 PJ). Contributing to this increase were the freight and passenger segments, which increased by 62 percent and 28.9 percent respectively.

- Structure – Shifts between modes of transport within both the freight and passenger segments caused an increase of 9.4 percent in transportation energy use (176 PJ). Specifically, an increase in international trade and customer requirements for just-in-time delivery and the popularity of minivans and sport utility vehicles (SUVs) contributed to a rise in energy use.

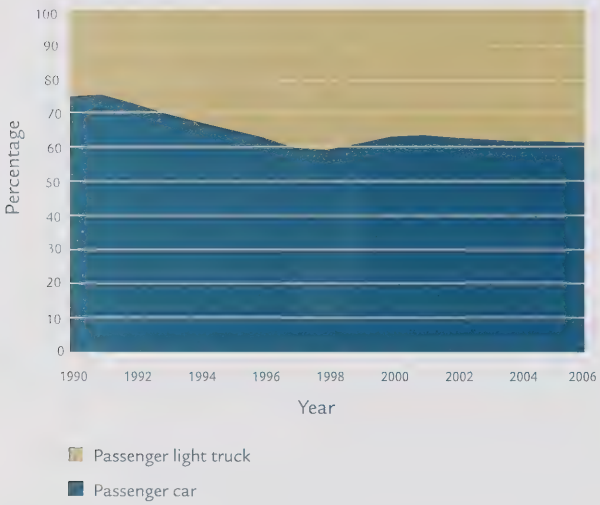
- Energy efficiency effect – Improvements in the energy efficiency of passenger and freight transport decreased energy use by 18.2 percent (342.2 PJ).

[5] Measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation.

Figure 1-18 shows how the market share of new light trucks increased in the 1990s, reflecting the increase in popularity of minivans and SUVs. Recently, however, this trend seems to have stabilized, with the share of light trucks remaining steady over the past few years. The higher share of heavier and more powerful passenger vehicles has had a significant effect on the increase in passenger energy use.

FIGURE 1-18

Market Shares of New Passenger Car and Light-Truck Sales, 1990 to 2006



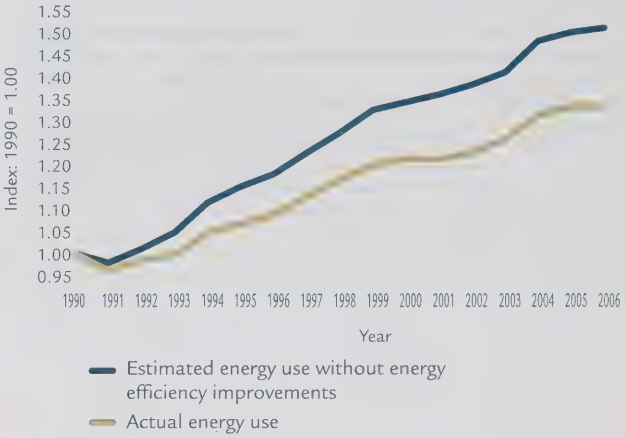
Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tran_ca.cfm?attr=0

Energy Efficiency

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 50 percent. However, between 1990 and 2006, actual energy use increased by 33 percent. During this period, energy efficiency in the transportation sector improved by 18.2 percent, leading to a savings of $8.7 billion in 2006. This change in energy use between 1990 and 2006 and the estimated energy savings due to energy efficiency improvements are shown in Figure 1-19.

FIGURE 1-19

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

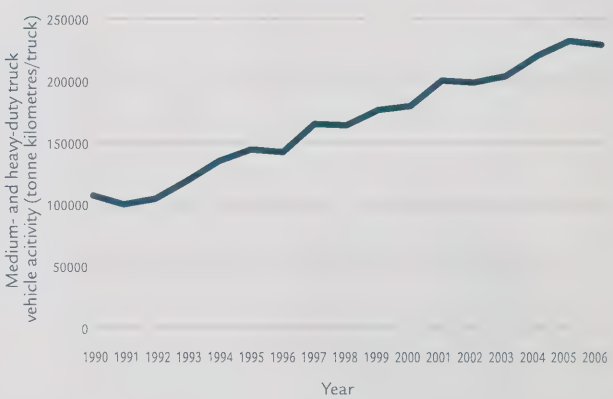


Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tran_ca.cfm?attr=0

Figures 1-20 and 1-21 illustrate an improvement in trucking energy intensity despite an increase in average activity from 1990 to 2006. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have improved fuel efficiency in medium- and heavy-duty trucks.

FIGURE 1-20

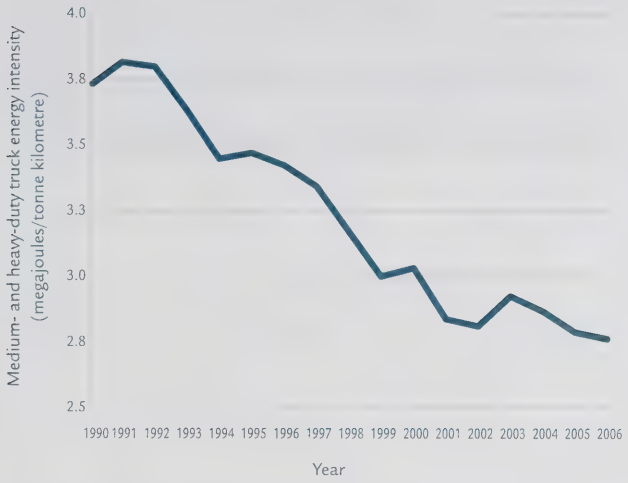
Average Activity per Truck, 1990 to 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0

FIGURE 1-21

Trucking Energy Intensity, 1990 to 2006



Source: Natural Resources Canada, Transportation End-Use Models, Ottawa, 2008.

NRCan carries out the following initiatives to increase the efficiency of motor vehicle use:

- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- Clean Transportation Energy

TRENDS IN ALTERNATIVE AND RENEWABLE FUELS

Alternative and Renewable Fuels

Alternative fuels are fuels used for transportation other than petroleum-based gasoline and diesel. Some alternative transportation fuels, such as ethanol and biodiesel, are renewable; others, such as propane and natural gas, are non-renewable. Other possible alternative transportation fuels include next-generation biofuels, coal-to-liquids, electricity and hydrogen.

Renewable fuel is a broad term covering a range of fuels made from renewable energy sources that are naturally replenished in a relatively short period. The sources include biomass, hydropower, geothermal energy, wind energy and solar energy.

Biofuel is a well-known category of renewable fuel and can be produced from a variety of sources. Two commercially available biofuels are ethanol and biodiesel. Conventional ethanol is produced from sugars or starches, and biodiesel production typically uses vegetable oils and animal fats. In Canada, ethanol is typically produced from corn and wheat, while canola oil, soy oil and tallow are relevant biodiesel feedstocks.

Gasoline vehicles manufactured since the 1980s can use up to 10 percent ethanol in gasoline. An increasing number of original equipment manufacturers are endorsing the use of lower biodiesel blends, for example, up to 5 percent in diesel engines. Under development are next-generation biofuels, such as cellulosic ethanol. These biofuels could be made from non-conventional sources, such as agricultural residues, forest residues and waste materials.

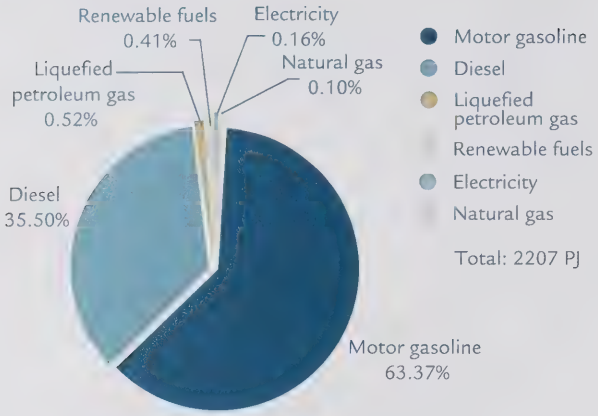
Renewable Fuels Production

Renewable fuels production in Canada has increased since the emergence of ethanol in Manitoba in the 1980s. Between 2005 and 2008, domestic renewable fuel production capacity increased by approximately 1.3 billion litres (L), from 211 million L to 1.5 billion L. By the end of the 2008–2009 fiscal year, ethanol production capacity was 1.4 billion L and biodiesel production capacity was over 100 million L. For the 2008 calendar year, 814 million L of ethanol and approximately 85 million L of biodiesel were produced.

In 2006, renewable fuels used in the transportation sector represented less than 0.5 percent of fuel used, as shown in Figure 1-22. The renewable fuel consumed was predominately ethanol blended with gasoline in lower-level ethanol blends.

FIGURE 1-22

Shares of On-Road Transportation Fuel, 2006



Source: oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0

Regulations under development by Environment Canada will require 5 percent renewable content based on the gasoline pool by 2010 and 2 percent renewable content in diesel and heating oil by 2012, upon successful demonstration of renewable diesel fuel use under the range of Canadian conditions.

NRCan carries out initiatives to increase the use and production of renewable and alternative fuels under the following programs:

- ecoENERGY for Biofuels
- National Renewable Diesel Demonstration Initiative
- Sustainable Development Technology Canada's NextGen Biofuels Fund™

CHAPTER 2

Equipment, Standards and Labelling

INTRODUCTION

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes standards and labelling programs that are based on the requirements of Canada's *Energy Efficiency Regulations* (the Regulations).

The *Energy Efficiency Act* (the Act) of 1992 gives the Government of Canada the authority to make and enforce regulations that prescribe standards and labelling requirements for energy-using products that are imported to Canada or shipped across provincial borders for lease or sale. The *Energy Efficiency Regulations* came into effect in February 1995, after extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. Since then, the Regulations have been amended a number of times.

The performance standards contained in the Regulations and accompanying labelling requirements and programs make a major contribution to the government's Clean Air Regulatory Agenda (CARA).

Regulations have now been established for more than 40 products including major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors, commercial refrigeration and some lighting products. The Regulations apply to these products even if they are incorporated in a larger unit or machine that is not regulated.

As announced by the Government of Canada in October 2006, the Regulations will be amended to prescribe standards for 20 new products and increase the stringency of existing standards for 10 products by 2010. When these standards are implemented, there will be a standard in place for products that use 80 percent of the energy consumed in the residential and commercial/institutional sectors.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products when the market has achieved a higher level of efficiency. The Regulations are also amended to add new products, harmonize minimum energy performance requirements with those of other jurisdictions and update testing methodologies and labelling requirements.

In addition, regulations can be established for gathering market data on the energy performance of certain types of equipment. For example, the data gathered for gas fireplaces are used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before amending the Regulations, NRCan conducts studies to determine how the proposed change will affect the market. A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and the Regulations, as well as on their practical application in the marketplace.

The Act and the Regulations also support labelling initiatives. These are designed to help consumers and the commercial/industrial procurement community identify and purchase energy-efficient

equipment that will save them money and reduce greenhouse gas (GHG) emissions over the life of the product.

The Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners or, as in the case of the newly implemented requirement for light bulb labelling, on the product packaging. For appliances, the EnerGuide label shows the estimated annual energy consumption of the product in kilowatt hours and compares it with the most and least efficient models of the same class and size. The EnerGuide label for room air conditioners indicates the model's energy efficiency ratio and provides a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product is published on the back page of the manufacturer's brochure. These ratings include the annual fuel utilization efficiency rating for oil and gas furnaces, the fireplace efficiency rating for gas fireplaces and the seasonal energy efficiency ratio for central air conditioners.

The ENERGY STAR® Initiative in Canada works with and complements the Regulations and comparative EnerGuide label. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy-efficient on the market.

Products that are prescribed in the Regulations and are also part of the Initiative must meet levels of energy efficiency significantly above the minimum performance levels set out in the Regulations to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, their efficiency levels trigger the development of new minimum energy performance standards.

STANDARDS

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world. This practice minimizes the regulatory burden on manufacturers and avoids confusion for consumers.

For example, the performance requirements in the Regulations are similar to those in the five Canadian provinces that currently regulate energy-using equipment manufactured and sold within their borders. This alignment is achieved because governments support and participate in the development of national, consensus-based performance standards by accredited standards-writing organizations, such as the Canadian Standards Association.

Such standards include testing procedures that are used to determine a product's energy performance and are usually referenced federally and provincially. NRCan works closely with provinces throughout the regulatory process to ensure that the federal and provincial standards regimes are harmonized to the maximum extent possible. Because the North American market is highly integrated, Canada's energy performance requirements for many products are similar to regulations in the United States.

Canada is an active participant in international and regional forums, such as the Security and Prosperity Partnership of North America, involving the United States and Mexico, and the Asia-Pacific Partnership on Clean Development and Climate. Both these efforts contribute to regional co-operation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of these working groups.

NRCan supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission.

COMPLIANCE AND ENFORCEMENT

The Regulations outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use enforcement measures when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the Act prescribes specific enforcement measures when dealers violate the law.

Enforcement activities include preventing the importation of non-compliant products to Canada, preventing the sale or lease of non-compliant products in Canada and imposing fines. Violators can also be fined under the Administrative Monetary Penalty System of the Canada Border Services Agency for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

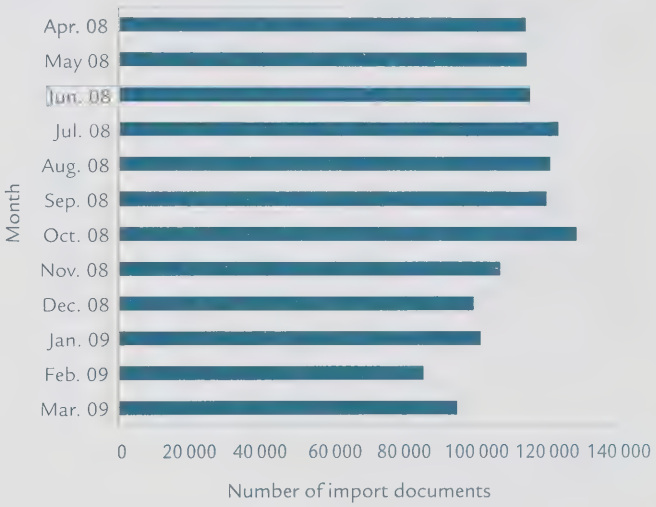
To monitor compliance with the Regulations, NRCan captures information from energy efficiency reports and import documents. Section 5 of the Act requires dealers to provide energy efficiency reports when they market a new product model. The required information includes the energy performance of each model, the name of the testing agency and the size category, as described in Schedule IV of the Regulations.

The Regulations require that when importing a regulated product into Canada, dealers provide specific product information on customs documents for all shipments (i.e. type of product, brand name, model number, name and address of dealer and purpose of import). A customs document contains less information than an energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan can then confirm that all products entering Canada meet the required energy performance levels and can take action when necessary.

NRCan processed more than 1 316 893 records (records from April 1, 2008, to March 31, 2009) relating to the importation of regulated energy-using products to Canada in 2008–2009.

Figure 2-1 illustrates the volume of import documents received per month during the 2008–2009 fiscal year.

FIGURE 2-1
Volume of Monthly Import Documents



Source: OEE equipment database.

More than 1 078 965 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2008, to March 31, 2009) from dealers' energy efficiency reports.

REGULATORY IMPACT TO DATE FROM THE REGULATORY IMPACT ANALYSIS STATEMENT

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette, Part II*.

It is estimated that Canada's energy performance standards from the 10 amendements will cause a reduction of 26 megatonnes (Mt) in aggregate annual emissions by 2010 (see Table 2-1).

TABLE 2-1
Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)

Product (amendment number in brackets)	Energy savings (PJ)		CO_2 reductions (Mt)	
	2010	**2020**	**2010**	**2020**
Residential appliances (1)	117.20	133.84	13.26	15.60
Lamps – fluorescent/incandescent (2)	11.60	13.40	7.55	9.80
Motors (3)	16.30	17.70	2.03	2.14
Commercial HVAC (4)	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49*	1.10*
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39*	0.94*
Clothes washers, domestic hot water, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (9)	1.57	5.35	0.16	0.53
General service lighting, commercial and industrial gas unit heaters, traffic and pedestrian signals, ceiling fan lighting, torchiere lamps, commercial clothes washers, residential wine chillers, commercial ice-makers, residential dishwashers, residential dehumifiers, residential gas furnaces (10)	6.09	88.10	0.40	9.67
Total	**184.24**	**328.96**	**26.00**	**43.96**

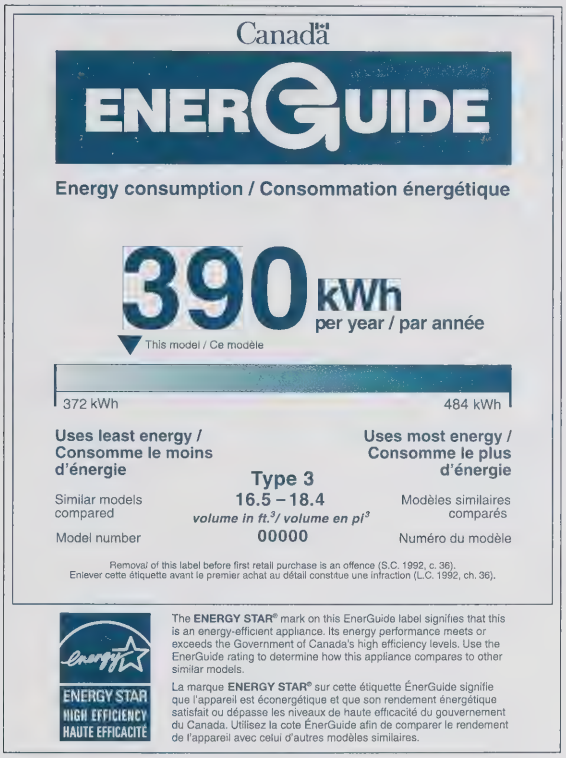
*Values are different from Regulatory Impact Analysis Statement due to a change in the emission factor to 99.3.

LABELLING AND PROMOTION

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of appliances. In 1995, with the introduction of the Regulations, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. The label on a product shows how much energy a product uses, allowing the customer to consider the most energy-efficient choice.

FIGURE 2-2

EnerGuide Label



EnerGuide directories that list energy ratings for major appliances and room air conditioners are published annually. They are distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. Online directories for all appliances and heating and cooling equipment are published on the Web site of the Office of Energy Efficiency (OEE) and updated monthly.

A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, gas fireplaces were added to the EnerGuide rating program, and manufacturers were asked to include EnerGuide ratings for fireplace efficiency in their brochures. These changes coincided with the mandatory requirement in the Regulations to test, verify and report on fireplace efficiency.

Major distributors of these products for sale in Canada report the verified energy performance rating of their products, as tested against the standards in the Regulations. In addition, participants in the voluntary EnerGuide rating program must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that can result from labelling.

Given that the equipment products listed above are typically purchased from a brochure or catalogue, a consumer would probably not read the EnerGuide label before making a decision to buy. Accordingly, manufacturers are encouraged to include an EnerGuide rating in product brochures and catalogues, so consumers can compare the efficiency of products when they are in the buying process. To date, manufacturers of 85 percent of eligible products on the market voluntarily participate in the EnerGuide rating program and publish the ratings in their brochures.

Regularly conducted polls indicate that more than 50 percent of Canadians surveyed are aware of the EnerGuide label.

In 2001, responding to public interest in a labelling system that identifies the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). Canada signed an agreement with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The OEE is the custodian

of the program for Canada. Canada joins other international ENERGY STAR program participants: Australia, New Zealand, Japan and Taiwan, and the European Union, which adopted ENERGY STAR for office equipment.

FIGURE 2-3
ENERGY STAR® Label

ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected on the basis of their technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the eligibility criteria and performance levels. For appliances and heating and cooling products, the criteria are based on the same test standards as those applied under the Regulations. Canada promotes specific product categories for which levels and criteria can be harmonized with those of the United States, including the following:

- major electrical appliances
- heating, cooling and ventilation
- consumer electronics
- office equipment
- windows, doors and skylights (Canadian levels)
- selected lighting products – compact fluorescent lamps (CFLs), fixtures, decorative light systems and solid-state lighting
- selected commercial equipment, including commercial refrigeration products

Canada has also integrated ENERGY STAR with the EnerGuide label for qualified major appliances and room air conditioners, to help consumers identify the best-performing products. While the EnerGuide label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. Now that industry-accepted standards of high efficiency have been established, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

ENERGY STAR is used as the basis for incentives by many electrical and gas utilities across Canada. For example, Hydro-Québec promotes ENERGY STAR qualified refrigerators, freezers, clothes washers and CFLs as part of its *Mieux Consommer* program and provides incentives for these product categories. Enbridge Gas and Manitoba Hydro have developed point-of-sale and incentive programs around ENERGY STAR qualified gas-fired heating systems.

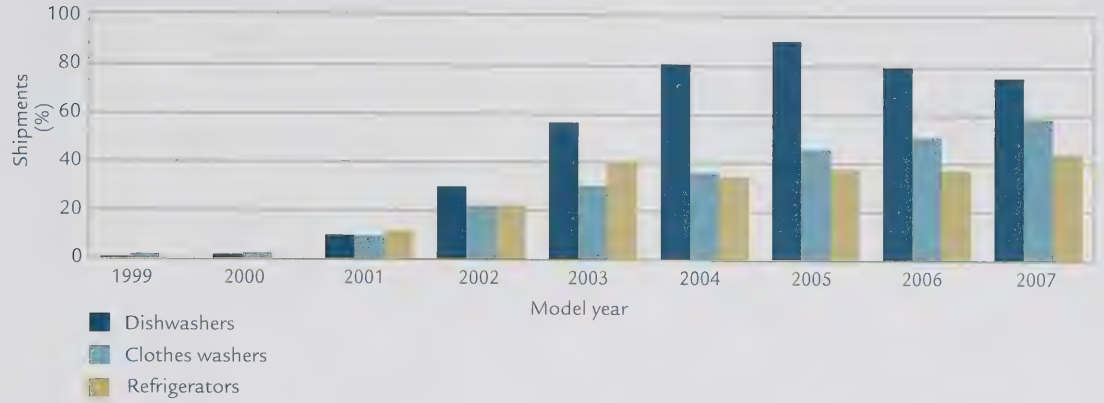
ENERGY STAR is also the qualifying criterion for sales tax exemptions in British Columbia for heating and cooling equipment; in Saskatchewan for the purchase of furnaces and boilers; and in Ontario for a variety of ENERGY STAR qualified products. Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher efficiency products.

Continuous promotion of ENERGY STAR qualified appliances has paid off. Industry statistics for 2007 show an increase in market penetration from almost nil in 1999 to 44 percent for refrigerators, 58 percent for clothes washers and 76 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and manufacturers' willingness to raise the efficiency of their products to qualifying levels.

ENERGY STAR specifications and levels are periodically updated as product saturation is

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Shipments in Canada, 1999 to 2007



Source: Energy Consumption of Major Appliances Shipped in Canada, Summary Report. Trends for 1990–2007.

reached, to encourage industry to strive for more efficient products and thus maintain the relevance and credibility of the brand.

ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to vending machines. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and to address barriers to their widespread acceptance.

Canada continues to promote ENERGY STAR guidelines in its contacts with the procurement community. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. Workshops were held across Canada to make governments and institutions aware of the ENERGY STAR criteria and procurement tools.

Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products for replacement equipment.

Canada continues to expand the range of product types included in its ENERGY STAR agreement. Canada led the way in the development of a technical specification for decorative light strings (also known as Christmas lights) and implemented this specification for Canada. In addition, Canada recently included fixtures, solid state lighting and external power supplies in its agreement with the Government of the United States. Finally, Canada is developing an ENERGY STAR specification for heat recovery ventilators.

NRCan developed a rating and labelling system for efficient refrigeration applications in ice and curling rinks under the name CoolSolution.[6] An ice rink application is qualified CoolSolution if it achieves a rating higher than 50 percent. An incentive program to encourage the adoption of CoolSolution and reduce the initial payback of the first applications started in November 2006. Partnerships to accelerate the program have been successful.

CoolSolution designates innovative technologies and practices and consists of three main elements:

[6] CoolSolution is an official mark of Her Majesty the Queen in the Right of Canada as represented by the Minister of Natural Resources.

- heat recovery from the refrigeration system to meet all the building's heating requirements (e.g. hot air, hot water) or to export this energy for other purposes.

- adaptation to the Canadian climate by taking advantage of the naturally occurring cold temperatures. This is done by varying the temperature of the heat released into the environment according to the outdoor temperature.

- reduction of the synthetic refrigerant charges of the refrigeration system, which have a serious adverse impact on climate change. This is done by using natural refrigerants or by confining the synthetic refrigerant to the mechanical room and using environmentally friendly fluids to remove and distribute heat.

ecoENERGY FOR EQUIPMENT

Objective

To exclude the least efficient energy-using equipment from the market and to influence consumers to select – and manufacturers to produce – energy-efficient products that perform above minimum standards.

Description

The ecoENERGY for Equipment program is focused on accelerating the introduction of energy-efficient products in Canada's equipment stock. The program implements minimum energy efficiency performance standards that restrict the importation and interprovincial shipment of the least efficient products for sale in Canada. It also carries out initiatives to increase the market share of more efficient products.

ecoENERGY for Equipment also supports labelling programs that encourage the introduction of more efficient technologies. This involves the establishment and promotion of high-efficiency performance criteria, such as ENERGY STAR, and the engagement of stakeholders to promote products that meet these criteria. As products are adopted in the marketplace, the ENERGY STAR or equivalent performance level will become the basis for new, more stringent standards.

In addition, ecoENERGY for Equipment maintains a multilayered compliance and enforcement program to ensure that products meet prescribed standards and to ensure that other regulatory requirements, such as labelling, are met.

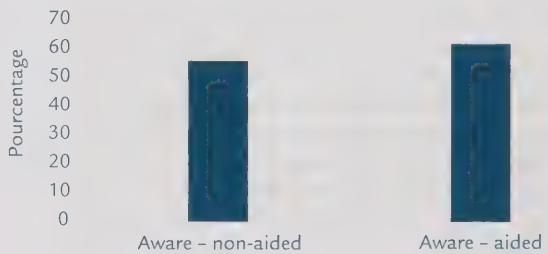
Program components include the following:

- regulations under the *Energy Efficiency Act* requiring dealers to ship only products that meet the prescribed energy efficiency standards

- the EnerGuide program, which rates and labels the energy efficiency of major household electrical appliances and heating, ventilating and air-conditioning equipment, assisting consumers in making energy-wise purchases

- the ENERGY STAR high efficiency program, which is an international initiative that identifies the most energy-efficient products in their class (see Figure 2-5)

FIGURE 2-5
ENERGY STAR Awareness Levels in Canada, 2007



Source: Tracking Study: Awareness of ENERGY STAR/EnerGuide Symbols 2007, Ipsos Reid.

Key 2008–2009 Achievements

- Introduced amendments to the *Energy Efficiency Act* into Parliament that give Canada the legislative authority to introduce comprehensive standards to regulate the amount of standby power consumed by many products – such as computers, battery chargers, CD players and televisions – when they are not in use.

- Published Amendment 10 to the *Energy Efficiency Regulations*. This amendment introduces standards for seven previously unregulated products and increases the stringency of existing standards for four products. The amendment includes standards for general service light bulbs that are scheduled to begin coming into effect in 2012. Standards in the amendment will reduce annual GHG emissions by an estimated 9.67 Mt in 2020.

- Conducted the analysis and consultation necessary to pre-publish Amendment 11 to the *Energy Efficiency Regulations*. Amendment 11 includes standards for six previously unregulated products and increases in the stringency of the existing standards for seven products.

- Delivered four specialized workshops on ENERGY STAR to the procurement and institutional community.

- Updated and maintained a comprehensive database of ENERGY STAR qualified products and information that assists utilities and other organizations across Canada in their energy efficiency programs (rebates, incentives and tax exemptions).

- Published and implemented 10 new ENERGY STAR technical specifications.

- Undertook 10 market assessments.

For more information:
oee.nrcan.gc.ca/corporate/about-us.cfm?attr=0

CHAPTER 3

Energy Efficiency and Alternative Transportation Fuels

Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) aims to strengthen and expand Canada's commitment to energy efficiency in all sectors and increase the production and use of alternative transportation fuels in Canada. The OEE is the manager of the ecoENERGY Efficiency Initiative, under the ecoENERGY suite of programs initiated on April 1, 2007. The ecoENERGY Efficiency Initiative includes the following programs:

- ecoENERGY Retrofit
- ecoENERGY for Buildings and Houses
- ecoENERGY for Industry
- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- ecoENERGY for Biofuels
- ecoENERGY for Equipment (see Chapter 2)

In addition to ecoENERGY, the OEE manages the Federal Buildings Initiative and the National Renewable Diesel Demonstration Initiative (NRDDI).

This chapter describes the objective of each of the aforementioned programs and outlines key achievements.

ecoENERGY RETROFIT

Objective

To provide incentives for energy efficiency improvements in homes and in small and medium-sized organizations in the institutional, commercial and industrial sectors. The program has two components:

- ecoENERGY Retrofit – Homes
- ecoENERGY Retrofit – Small and Medium Organizations

For more information:
ecoaction.gc.ca/retrofit

ecoENERGY RETROFIT – HOMES

Objective

To assist homeowners and owners of existing low-rise properties make smart energy retrofit decisions that will result in significant energy savings and a cleaner environment.

Description

Initiated on April 1, 2007, the ecoENERGY Retrofit – Homes program is investing $460 million over four years, providing federal grants to property owners for improving the energy efficiency of their homes and reducing their home's impact on the environment. ecoENERGY Retrofit – Homes offers a professional evaluation by a qualified energy advisor of the energy efficiency characteristics of a house, including a diagnostic test to determine air leakage.

The energy advisor prepares a detailed personalized checklist of recommended upgrades for the property owner, including the EnerGuide pre-retrofit energy rating of the house. The checklist shows the recommended, most effective upgrades. The property owner chooses which upgrades to have done.

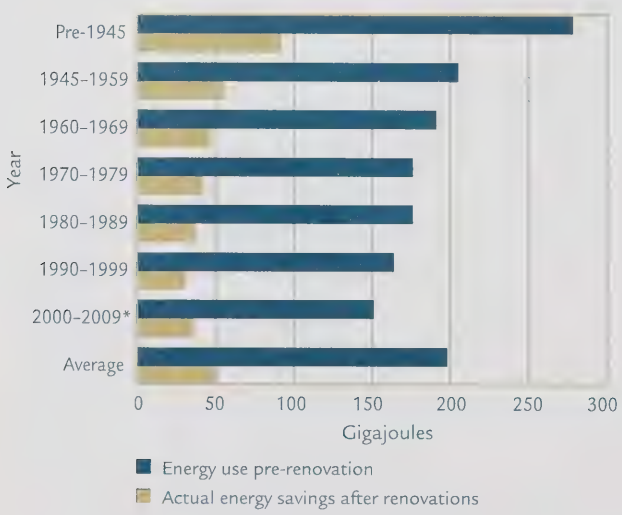
After the retrofit work is complete, the advisor performs a post-retrofit energy evaluation and assigns a new energy-rating label. After the required improvements have been made, the property owner is entitled to a grant.

The program was expanded in 2009 to support as many as 200 000 additional homeowners in making energy efficiency retrofits to their homes. The expanded program includes a $300-million increase in funding over two years, well as a 25 percent increase in the grant amount (up to $5,000 per unit).

It is expected that the ecoENERGY Retrofit – Homes incentives will promote smart energy use in more than 340 000 homes and will yield an average 23 percent reduction in energy use.

FIGURE 3-1

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2009



*Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

Figure 3-1 illustrates the energy use and savings gained per household before and after renovations.

Key 2008–2009 Achievements

- From April 1, 2007, to the end of the 2008–2009 fiscal year, grants were made to 94 000 homeowners to support energy efficiency upgrades that will reduce their annual energy consumption.
- Over the same time period, 19 000 grants were paid for more energy-efficient renewable technologies and products, including water conservation equipment, wood burning appliances, ground-source heat pumps, solar domestic hot water systems and drain water treatment recovery pipes (representing 20 percent of program participants).
- All regions of Canada, except one province and one territory, have matching programs from which homeowners can get seamless access to both federal and provincial/territorial government support for home retrofits.
- At the end of the 2008–2009 fiscal year, agreements had been signed with nine provinces and two territories.
- The ecoENERGY Retrofit – Homes program will help participants reduce their annual energy consumption by about 23 percent and GHG emissions by approximately 3.4 tonnes (t) per house per year.
- Since program inception, a reduction of approximately 0.32 megatonnes (Mt) of greenhouse gas (GHG) emissions can be attributed to the ecoENERGY Retrofit – Homes program.

ecoENERGY RETROFIT – SMALL AND MEDIUM ORGANIZATIONS

Objective

To encourage building owners and managers of commercial and institutional buildings and industries to implement energy efficiency projects.

Description

Initiated on April 1, 2007, ecoENERGY Retrofit – Small and Medium Organizations is investing $40 million over five years, providing financial incentives to implement energy retrofit projects in buildings and industrial equipment and processes. Industrial facilities with fewer than 500 employees and commercial and institutional buildings of less than 20 000 square metres may be eligible for funds through contribution agreements with the program.

ecoENERGY Retrofit will provide up to 25 percent of the cost of a project, to a maximum of $50,000, based on estimated energy savings resulting from the project. Recipients of funding in this category may also qualify for funding support from utilities and/or other levels of government. To qualify, eligible organizations must submit an application detailing the energy efficiency project, including the total budget, timeframe for completion and expected results, based on a certified technical assessment of the building's or industry's energy use.

Key 2008–2009 Achievements

- Webinars and information sessions hosted 460 participants.
- 279 small and medium-sized organizations had their planned retrofit projects approved for financial assistance.
- Since program inception, the program has approved projects that will save approximately 0.08 Mt of GHG emissions.

ecoENERGY FOR BUILDINGS AND HOUSES

Objective

To encourage the construction and operation of more energy-efficient buildings and houses through a range of complementary activities, such as rating, labelling and training.

Description

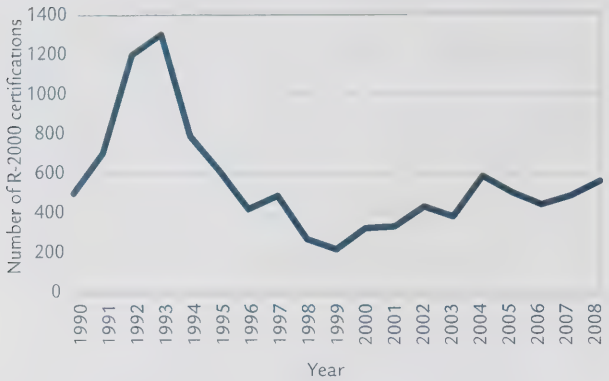
Initiated on April 1, 2007, the ecoENERGY for Buildings and Houses program is investing $60 million over four years and includes the following activities for the buildings sector:

- implementing new design tools and training, such as the Dollars to $ense workshop, so designers, builders, owners and operators can learn about and use best practices and new technologies for energy-efficient buildings
- updating building energy ratings and promoting labelling systems for housing, including the EnerGuide Rating System, the R-2000 Standard[7] and ENERGY STAR® for New Homes, to encourage consumers to invest in energy-efficient upgrades during the construction planning phase of building a new home (see Figure 3-2)
- supporting the National Research Council financially in updating the *National Energy Code for Buildings*
- engaging in ongoing dialogue and co-operation with provincial and territorial programs to encourage other levels of government to adopt more stringent building energy codes
- providing training and implementing outreach and communication strategies to increase awareness and build capacity among builders, building owners, managers and consumers to support the adoption of sustainable energy efficiency programs

[7] R-2000 is an official mark of Natural Resources Canada.

- establishing and maintaining partnerships to reduce energy use and improve energy efficiency information

FIGURE 3-2
Number of R-2000 Housing Certifications, 1990 to 2008



Source: NRCan national housing database and internal data.

Key 2008–2009 Achievements

- Issued more than 260 000 housing labels for new and existing houses.
- Seven building labelling pilot projects were underway with organizations across Canada, covering 320 buildings.
- More than 1800 building professionals took part in technical support workshops, and more than 4300 housing professionals, builders and energy advisors were trained.
- As of the end of the 2008–2009 fiscal year, six provinces (B.C., Man., Ont., Que., N.B., N.S.) had announced changes to their building codes to achieve the ERS80 level by 2012. All but two provinces and territories participate in the Building Energy Code Collaborative.
- National Research Council is on schedule to complete the update of the *National Energy Code for Buildings* in 2011.
- Since program inception, an estimated 0.77 Mt of GHG emissions were saved as a result of the ecoENERGY for Buildings and Houses program.

For more information:
ecoaction.gc.ca/ecoenergy-ecoenergie/buildingshouses-batimentshabitations-eng.cfm

ecoENERGY FOR INDUSTRY

Objective

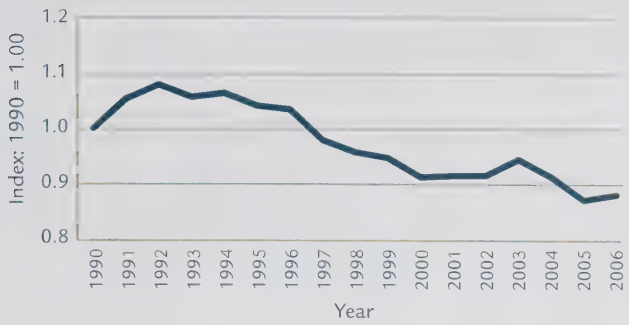
To improve industrial energy intensity and reduce energy-related industrial GHGs and air pollution.

Description

Initiated on April 1, 2007, the ecoENERGY for Industry program is investing $18 million to accelerate energy-saving investments and the exchange of best-practices information within Canada's industrial sector. The program helps industry become more energy efficient by providing it with tools and services for overcoming the technical, management and financial barriers to project implementation.

ecoENERGY for Industry is an industry-government partnership delivered through the Canadian Industry Program for Energy Conservation (CIPEC). CIPEC is committed to promoting and encouraging energy efficiency improvements, as well as reductions in GHG emissions through voluntary action across Canada's industrial sectors. The estimated CIPEC energy intensity index is shown in Figure 3-3.

FIGURE 3-3
CIPEC Energy Intensity Index, 1990 to 2006

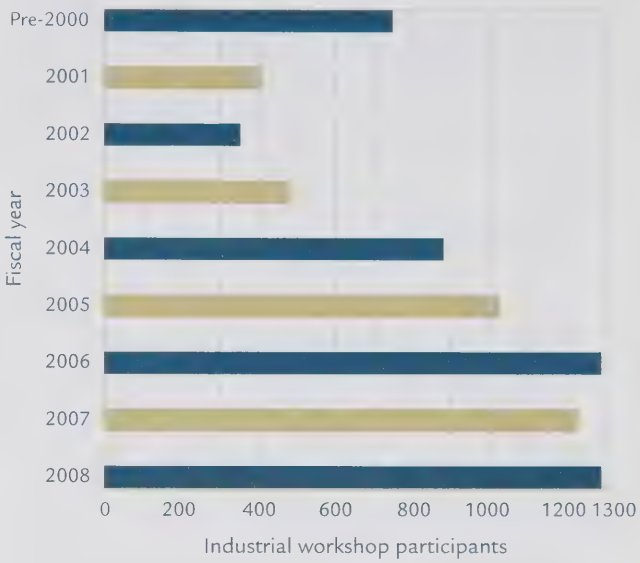


Source: CIPEC Annual Report 2008.

Program components include the following:

- the Dollars to $ense energy management workshops, which teach industry members how to improve operational efficiency, create a better work environment and reduce GHG emissions (see Figure 3-4)
- the ecoENERGY Assessment Incentive for Industry, which offers a financial incentive to help industrial companies conduct state-of-the-art process integration and computational fluid dynamics studies that identify opportunities to increase energy efficiency and improve production processes
- the CIPEC Leaders network, which demonstrates the industrial sector's commitment to reducing energy use, gives members recognition, networking opportunities for best-practice sharing and eligibility for financial incentives

FIGURE 3-4
Industrial Dollars to $ense Participants, Pre-2000 to 2008



Source: CIPEC.

Key 2008–2009 Achievements

- Delivered Dollars to $ense energy management workshops for 760 industrial participants.
- Six benchmarking studies, technical guides and other tools were developed, leading to improved energy efficiency in Canadian industry.
- Welcomed 191 new members to the CIPEC Leaders network, which has 1800 members, and held 77 network meetings.
- Since program inception, ecoENERGY for Industry helped Canadian industry avoid approximately 0.74 Mt of GHG emissions.

For more information:
ecoaction.gc.ca/ecoenergy-ecoenergie/industry-industrie-eng.cfm

ecoENERGY FOR PERSONAL VEHICLES

Objective

To facilitate and support improvements in energy efficiency by encouraging Canadians to buy, drive and maintain their vehicles with fuel efficiency in mind.

Description

Initiated April 1, 2007, the ecoENERGY for Personal Vehicles program is investing $21 million over four years to provide Canadians with helpful information, tips and decision-making tools to assist them in changing their buying, driving and maintenance behaviours in order to reduce fuel consumption and GHG emissions from their personal vehicle use. It does so through the following:

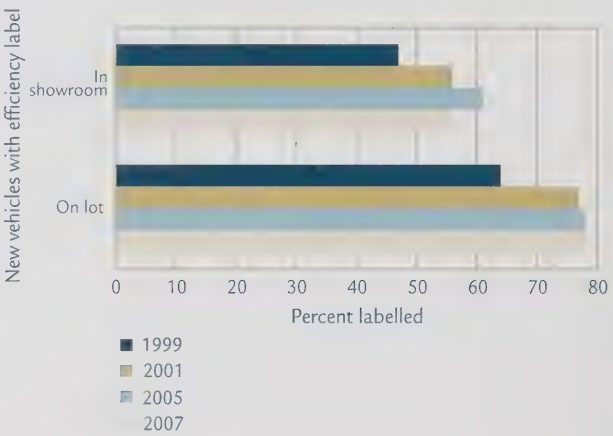
- decision-making information and tools, such as the annual *Fuel Consumption Guide*, labels and vehicle awards
- "Eco" driver education and training
- idle-free and tire inflation campaigns
- collaborative ventures with community groups and industry stakeholders

ecoENERGY for Personal Vehicles also facilitates work with the vehicle industry to implement and monitor the voluntary memorandum of understanding (MOU) between the Government of Canada and the auto industry to reduce automobile GHG emissions.

Program components include the following:

- the EnerGuide labelling system, which places fuel consumption labels on all new light-duty vehicles sold in Canada (see Figure 3-5)
- the 2005 MOU between the Government of Canada and the Canadian auto industry, which provides a framework for automakers to produce more fuel-efficient and lower-GHG-emission vehicles by 2010 (see Figure 3-6)
- the annual ecoENERGY for Vehicles Awards, which recognize and identify for consumers, the most fuel-efficient light-duty vehicles in their classes available in Canada
- the Auto$mart driver education series, which teaches drivers how to drive safely, save fuel and money, and protect the environment by using fuel-efficient driving techniques
- idle-free and tire maintenance campaigns that use educational materials and outreach activities to encourage drivers to embrace fuel-efficient practices

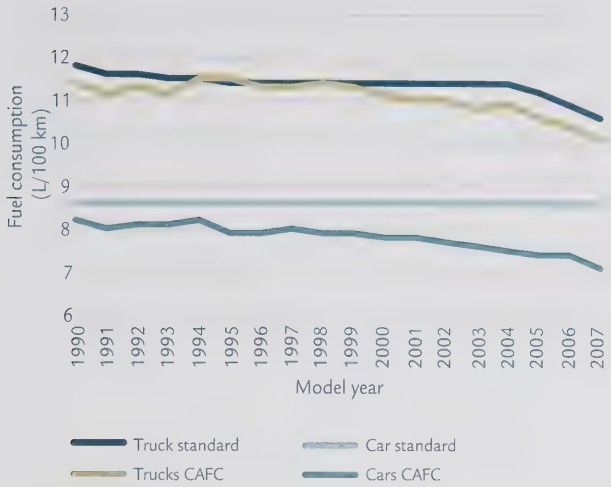
FIGURE 3-5
New Vehicle Fuel Efficiency Labelling



Source: Corporate research Associates, *2007 EnerGuide Label for Vehicles and Fuel Consumption Guide Audit Survey: Final Overall Report*, May 2007.

FIGURE 3-6

Company Average Fuel Consumption (CAFC) Versus Canadian Voluntary Standards, 1990 to 2007*



*2003–2007 data are estimates.

Source: www.tc.gc.ca/eng/programs/environment-fcp-cafctargets-385.htm

Key 2008–2009 Achievements

- Distributed more than 350 000 copies of the *Fuel Consumption Guide*, including 186 000 to 3386 new car dealerships and 53 000 to Canadian Automobile Association offices.
- Trained more than 440 000 new drivers annually in fuel-efficient driving practices.
- The "Be Tire Smart" campaign educated more than 7 million people about the environmental and fuel economy benefits of proper tire inflation and regular maintenance.
- Influenced 4 million drivers with the idle-reduction campaign.
- To date, the estimated GHG emission reductions associated with idle reduction and tire maintenance campaigns and with new driver training are 0.06 Mt.

For more information:

vehicles.nrcan.gc.ca

ecoENERGY FOR FLEETS

Objective

To achieve reductions in fuel use and related costs, air contaminants and GHG emissions through a wide range of measures targeting operators and managers of Canada's commercial and institutional road vehicle fleets.

Description

Initiated April 1, 2007, the ecoENERGY for Fleets program is investing $22 million over four years to promote the adoption of existing and emerging new technologies, such as energy-efficient vehicle components and hybrid technologies, and best practices, such as fuel management techniques.

ecoENERGY for Fleets is aimed at the commercial/institutional fleet transportation sector and provides information, workshops, technical demonstrations and training programs on fuel-efficient practices for fleet vehicles.

Program components include the following:

- the "Idle-Free Quiet Zone" campaign, which uses educational materials and incentives to encourage truck drivers to turn off their vehicles at truck stops
- Fuel Management 101 workshops, which assist fleet managers with the preparation, implementation and monitoring of a fuel management plan
- SmartDriver training programs, which offer knowledge sharing and on-the-road instruction to drivers of various types of fleets for the purpose of reducing fuel consumption

Key 2008–2009 Achievements

- Completed three idling awareness campaigns.
- Included 170 fleets in 12 Fuel Management 101 workshops to promote greater uptake of transportation energy efficiency practices.
- Trained 451 school bus drivers under the SmartDriver for School Bus program.
- Since program inception, a reduction of approximately 0.05 Mt of GHG emissions can be attributed to the ecoENERGY for Fleets program.

For more information:
fleetsmart.gc.ca

ecoENERGY FOR BIOFUELS

Objective

To support the production of renewable alternatives to gasoline and diesel and encourage the development of a competitive domestic renewable fuel industry.

Description

ecoENERGY for Biofuels is investing up to $1.5 billion over nine years to support the production of renewable alternatives to gasoline and diesel in Canada and encourage the development of a competitive domestic industry for renewable fuels.

Initiated on April 1, 2008, the program makes investments in production facilities more attractive by partially offsetting the risks associated with fluctuating feedstock and fuel prices.

The program provides an operating incentive to producers of renewable alternatives to gasoline, such as ethanol, and renewable alternatives to diesel, such as biodiesel, under conditions where industry requires support to remain profitable. In order to receive an incentive, eligible recipients must have signed a Contribution Agreement with NRCan and must have met the requirements of the *Canadian Environmental Assessment Act* and comply with all other applicable federal, provincial and municipal environmental legislation.

ecoENERGY for Biofuels is a key component of Canada's renewable fuels strategy, which aims to

- reduce the GHG emissions resulting from fuel use
- encourage greater production of biofuels
- accelerate the commercialization of new biofuel technologies
- provide new market opportunities for agricultural producers and rural communities

Key 2008–2009 Achievements

- The ecoENERGY for Biofuels program received 46 applications.
- The program deemed 24 applicants eligible for funding, and NRCan signed contribution agreements with 22 companies, representing a total commitment of $938 million and a domestic production of 1.6 billion litres (L) of biofuels (1.4 billion L of ethanol and 0.229 billion L of biodiesel).
- Seven information sessions were conducted across Canada in May and June 2008.

For more information:
ecoaction.gc.ca/biofuels

FEDERAL BUILDINGS INITIATIVE

Objective

To assist Government of Canada organizations in implementing energy efficiency upgrades that lead to reduced energy and water use, GHG emissions and operating costs.

Description

The Federal Buildings Initiative (FBI) is an energy efficiency program targeting federal departments and agencies and Crown corporations. The FBI provides a range of products and services required by an organization to implement comprehensive energy efficiency improvement projects in its facilities.

The products include case studies, workshops, technical information, model procurement documents and a list of qualified private-sector energy management firms that can provide energy performance contracting services. FBI services include facilitation such as energy management technical advice, program policy advice and procurement services to assist organizations in making energy efficiency improvements.

Other levels of government, institutions and private sector firms also draw on the FBI's experience for help in designing their own energy efficiency programs. Since its inception in 1991, the FBI helped upgrade thousands of square metres of federal building floor space, representing one third of the total federal floor space, saving $43 million in energy bills and reducing the risks associated with climate change.

Key 2008–2009 Achievements

- DFAIT Washington Embassy and PWGSC Place du Portage are proceeding with energy efficiency retrofit projects that are expected to save from 15 to 20 percent in annual energy costs.
- To date, the private sector has made new and incremental investments of $320 million in FBI projects.

For more information:
oee.nrcan.gc.ca/communities-government/buildings/federal/federal-buildings-initiative.cfm

NATIONAL RENEWABLE DIESEL DEMONSTRATION

Objective

Initiated in December 2008, the National Renewable Diesel Demonstration Initiative (NRDDI) will address questions from industry and end-users about renewable diesel use by demonstrating how it will perform under Canadian conditions.

Description

The Government of Canada is committed to expanding the production and use of a range of cleaner, renewable biofuels, including renewable diesel. The intent is to reduce GHG emissions that result from fuel use, encourage greater production of biofuels, accelerate the commercialization of new biofuel technologies and provide new market opportunities for agricultural producers and rural communities.

In December 2006, the Government announced its intention to develop a regulation requiring an average annual 2 percent renewable fuel content in diesel fuel and heating oil, upon successful demonstration of renewable diesel fuel use under the range of Canadian conditions.

Renewable diesel has been tested in a variety of vehicle engines under driving conditions in many parts of Europe and the United States. Renewable diesel has also been tested in certain applications in Canada, such as trucks, buses and marine vessels.

During consultation, Canadian industry sectors and end-users have raised questions related to large-scale integration of renewable diesel into fuel distribution networks. The NRDDI aims to address these remaining questions in advance of the proposed regulation coming into effect.

Non-repayable contributions will be provided to approved projects that demonstrate aspects of renewable diesel use and/or distribution in Canada. Funded projects may demonstrate one or more of the following:

- the use of various blend levels
- the use of fuels produced from various feedstocks
- the use of renewable diesel in various applications that diesel fuel is likely to encounter in Canada
- the infrastructure for renewable diesel storage and distribution

Funding will be available to facilitate demonstration projects of different scales in both the on-road transportation and off-road sectors.

Key 2008–2009 Achievements

- Consultations were conducted with industry stakeholders on program design to ensure program effectiveness.
- Program roll-out was completed, including online materials, application forms and a contribution agreement template.
- Reviewed initial proposals and started drafting the first contribution agreements.

For more information:

oee.nrcan.gc.ca/transportation/fuels/biodiesel/NRDDI

CHAPTER 4

Energy Science and Technology

INTRODUCTION

Natural Resources Canada (NRCan) invests in the research, development and demonstration (R,D&D) of new and emerging energy science and technology (S&T) that produces economic, social and environmental benefits for Canadians. NRCan's Office of Energy Research and Development (OERD) and CanmetENERGY lead the federal government's energy S&T operations.

The OERD oversees the management of the Program of Energy Research and Development (PERD) and the ecoENERGY Technology Initiative. These programs allocated more than $86.5 million in the 2008–2009 fiscal year. The funds help find new, long-term, cleaner and more efficient solutions to reducing environmental emissions by developing and disseminating new knowledge and new technologies through R, D&D initiatives. Slightly more than 75 percent of the programs and activities allocated by the OERD are managed and carried out by the Department (including CanmetENERGY). The six departmental priorities listed under CanmetENERGY also apply to OERD.

CanmetENERGY generates and provides knowledge and technologies to advance the development and use of innovative solutions contributing to the well-being of Canadians and to progress toward meeting Canada's economic, social and environmental policy objectives. It works with industry, academia, utilities, associations, non-governmental organizations and other governments to develop and demonstrate energy-efficient, alternative and renewable energy technologies and processes.

CanmetENERGY undertakes projects and activities in the following areas of expertise:

- clean energy systems for buildings and communities
- clean electric power generation
- clean energy systems for industry
- clean transportation energy
- environmentally sustainable oil and gas development
- sustainable bioenergy

This chapter describes in detail the programs, activities and 2008–2009 key achievements of the OERD, CanmetENERGY and other partners in energy S&T.

For more information:
nrcan.gc.ca/eneene/science/index-eng.php
canmetenergy.nrcan.gc.ca

PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT

Objective

To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

Description

The PERD supports R&D activities within nine portfolios, comprising oil sands and offshore

regulatory issues, sustainable bioenergy, reducing air impacts and improving efficiency in electricity as well as integration of alternative and renewable energy into the grid, and improving efficiencies in end-use, with focus on transportation, buildings and industry. Efficiencies are sought in energy production, distribution and end-use. Examples of funded projects are included in the areas of the program described in this chapter.

The portfolios are managed holistically and encompass the entire innovation spectrum, from basic research to applied research, pilot plants and demonstrations, ensuring faster deployment of technologies developed with federal funds.

The PERD budget for the 2008–2009 fiscal year was approximately $53.6 million. Of that amount, $16.7 million was allocated to 12 federal departments and agencies that are PERD partners, mostly to improve the science supporting Canadian regulations related to energy production and use. The remaining $36.9 million is allocated to energy R&D programs managed and performed in NRCan, more than 70 percent of which contributed to improved energy efficiency and the integration of renewable energy sources in Canada.

ecoENERGY TECHNOLOGY INITIATIVE

Objective

To support the development of next-generation energy technologies needed to break through to emissions-free fossil fuel production, as well as for producing energy from other clean sources, such as renewables and bioenergy and to advance the development and use of new clean energy technologies in end-use sectors.

Description

The ecoENERGY Technology Initiative is a component of ecoACTION, the government's actions toward clean air and greenhouse gas (GHG) emission reductions. It is a $230-million investment in clean energy science and technology. The funding helps in the search for long-term solutions to reducing and eliminating air pollutants from energy production and use.

Part of the funding has been allocated to the demonstration of carbon capture and storage. Eight projects have been selected in this area. Spending in the 2008–2009 fiscal year was nearly $31 million.

CLEAN ENERGY SYSTEMS FOR BUILDINGS AND COMMUNITIES

Objective

To develop, demonstrate and promote – in domestic and foreign markets – technologies, practical decision-making tools, processes, codes, standards and best practices that help communities select more efficient and cost-effective energy, waste and water technologies and design solutions to support a sustainable energy future based on reduced energy consumption and GHG emissions.

Description

CanmetENERGY plays a leadership role in the R,D&D of energy-efficient and renewable energy technologies for houses, buildings and communities by

- fostering the commercialization of new technologies
- identifying and developing opportunities for integration of technologies
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- supporting training and education
- disseminating results and findings

- facilitating the export of Canadian technologies to international markets

- engaging in international co-operation

Specific work includes the development of design, modelling and analysis tools and integrated design approaches, such as building energy simulation software making it possible to achieve greater energy efficiency to be implemented at minimal incremental costs. CanmetENERGY develops, distributes and supports building energy simulation software for the Canadian construction industry and Government of Canada ecoACTION programs.

CanmetENERGY is active in conceiving, developing and optimizing energy-efficient space and water heating, ventilation, air-conditioning and refrigeration technologies, and micro-cogeneration systems including standards development, energy efficiency labelling, heat recovery systems, combined heat and power and energy conversion and storage systems, integration of technologies and adaptation to the Canadian context.

CanmetENERGY assists in increasing the use of solar thermal and solar photovoltaic energy technologies in Canada by developing technologies, standards, policies and programs to create a Canadian-based, globally competitive solar industry. Other work includes community energy systems, daylighting, intelligent building controls and commissioning/recommissioning of buildings.

CanmetENERGY's partnerships with industry help to build advanced residential and commercial buildings that incorporate a wide array of innovative technologies and consume significantly less energy than their conventional counterparts. Under cost-sharing arrangements to accelerate the development and commercialization of a new generation of advanced and energy-efficient technologies, CanmetENERGY is helping the Canadian residential and commercial building industry produce some of the most environmentally advanced structures on the planet.

Key 2008–2009 Achievements

- CanmetENERGY is helping to update the *National Energy Code for Buildings*, the revised version of which will be released in 2011. The Standing Committee on Energy Efficiency in Buildings was formed with five task groups. CanmetENERGY is a member of three Task Groups: HVAC and Service Water Heating Systems, Building Envelope, and Building Energy Performance Compliance.

- CanmetENERGY facilitated the integrated design process of NRCan's new Materials Technology Laboratory at McMaster University in Hamilton, Ontario. The integrated design process is a new approach to designing net-zero energy buildings. This LEED® Platinum building is designed for 70 percent energy savings and more than 20 percent renewable energy supply.

- The first extensive study of residential hot water heating system performance in Canada is leading to a revision of performance test standards in Canada and the United States. Results of field testing tankless and conventional hot water tanks by CanmetENERGY highlight the need for updating current test methods to better reflect real use performance and efficiencies of these systems, while fostering development of more efficient technologies.

- CanmetENERGY research into residential and commercial combustion systems contributed to updates in Canada's *Energy Efficiency Regulations* requiring, by the end of 2009, that only highly energy-efficient condensing furnaces can be manufactured in and imported to Canada. This regulatory update followed years of CanmetENERGY research contributions to condensing technology development, Canadian Standards Association standards, and the Office of Energy Efficiency and ENERGY STAR® labelling programs in Canada.

- The Drake Landing Solar Community in Okotoks, Alberta, North America's first solar seasonal storage community, is meeting 65 percent of space heating needs with solar energy in its second year of operation. After it is fully charged, the solar storage system is expected to achieve a world record of meeting 90 percent of heating needs.

- CanmetENERGY increased the number of users of the RETScreen® Clean Energy Project Analysis Software to more than 193 000 people in 222 countries, adding an average of 1000 new users every week (see Figure 4-1). More than 170 colleges and universities worldwide are now using RETScreen for education. As well, CanmetENERGY released a new RETScreen Clean Energy Legal Toolkit that includes sample legal documents freely available from various organizations, newly created Finance Agreements for clean energy projects and an e-Textbook chapter and training slides on the legal aspects of clean energy projects.

- Working with Maisons Alouette Homes and solar building research network partners, CanmetENERGY supported the evaluation and demonstration of the first net-zero energy home project to be completed in Canada. In 2008, Maisons Alouette Homes received the Reconnaissance – Recherche et développement en habitation award. This exceptional prize was awarded to Maisons Alouette Homes out of 1250 eligible businesses, for its EcoTerra™ project.

- CanmetENERGY was instrumental in revising the new Canadian Standards Association (CSA) B52S1-09, Supplement No. 1 to B52-05 to the *Mechanical Refrigeration Code*. This modification will facilitate widespread deployment of carbon dioxide (CO_2) refrigeration systems. CO_2 is a natural refrigerant with a Zero Ozone Depletion Potential and a Greenhouse Warming Potential of 1 compared with 1000 to 4000 for fluorocarbon refrigerants. It is therefore a significant improvement over past chlorofluorocarbon and present fluorocarbon refrigerants.

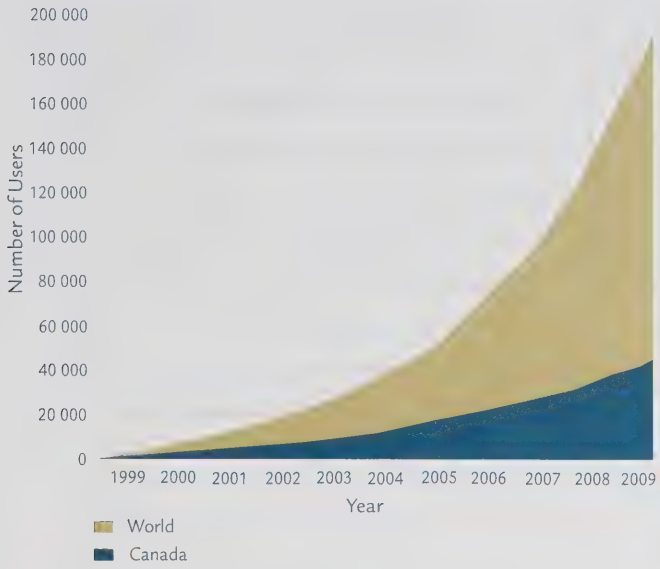
- Through NRCan scientific expertise, the Loblaws Superstore in Scarborough, Ontario, is operating Canada's first low-temperature display cases using CO_2 as a secondary refrigerant. NRCan also worked with the Technical Standards & Safety Authority and the CSA to obtain all the necessary approvals. The project is expected to reduce building energy consumption by 25 percent, synthetic refrigerant leaks by 95 percent and GHG emissions by 50 percent compared with a conventional supermarket.

- NRCan supported the development of an innovative refrigeration system that is installed in all Vancouver Olympic Games facilities requiring a refrigeration system. These technologies have become the preferred environmental solution for reducing the energy use, operating costs and carbon footprint when compared with conventional systems. These systems aim to reduce the total energy consumption of ice rinks, refrigerant quantities, refrigerant leaks and GHG emissions by 50 percent.

- CanmetENERGY has increased the number of qualified recommissioning (RCx) service providers (to about 100) by delivering a Canadian Advanced 3.5-day Retrocommissioning course (available in French and in English). CanmetENERGY also promotes its RCx methodology through its RCx guide. The RCx courses are part of CanmetENERGY's commitment to develop methodology, training programs, tools and case studies to help create awareness, promote standard practices and improve the performance of buildings systems.

FIGURE 4-1

RETScreen Software: Cumulative Growth of User Base



Source: NRCan/RETScreen Customer Database.

For more information:
canmetenergy.nrcan.gc.ca/eng/buildings_communities.html

CLEAN ELECTRIC POWER GENERATION

Objective

To develop and apply technologies for renewable electricity production and for cleaner power generation from fossil fuels, with the goal of increasing efficiency and achieving the reduction and, ultimately, the elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances, such as mercury, trace elements and organic compounds.

Description

CanmetENERGY's work on clean electric power generation focuses on improving the economics and efficiency of renewable energy technologies, including wind energy, solar power, small and low-head hydro, marine energy and energy storage.

CanmetENERGY's S&T supports the growth of the renewable energy industry in Canada by

- fostering the development of new technologies
- identifying and developing opportunities for building a smart power grid of renewable energy
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- conducting nationwide resource assessments and mapping

CanmetENERGY also focuses on improving the performance of, and reducing emissions from, existing fossil fuel power plants. Moreover, it focuses on developing new advanced cycles for the conversion of fossil fuels to electricity with complete or near-complete capture and elimination of CO_2 and other emissions. Additional research includes work on issues associated with the transport and storage of CO_2. Through advanced tools and technologies, CanmetENERGY assists major industrial energy consumers in reducing the energy intensity of their operations and in reducing GHG emissions and emissions of other air pollutants, while enhancing competitiveness and profitability.

CanmetENERGY's work on emerging technologies in clean power includes new forms of power generation, such as wind, solar photovoltaics, small hydro, marine, natural gas combined-cycle plants and advanced fluidized bed combustion. Significant R&D also focuses on CO_2-neutral combustion systems, CO_2 sequestration, CO_2 injection for enhanced oil recovery, advanced power generation cycles, clean coal technologies and distributed energy resources. CanmetENERGY also conducts leading-edge work in the burgeoning priority area of decentralized energy resources, where renewable energy sources are becoming more localized and integrated into the main power grid.

CanmetENERGY

- addresses the technical, institutional and regulatory barriers to clean power by promoting power grid integration, developing standards, generating knowledge and transferring important information to Canadian decision-makers
- provides stakeholders with the necessary information to make informed decisions, coordinates various research projects
- participates in international committees that establish standards and codes
- develops and hosts workshops and conferences
- develops publications and produces training tools
- capitalizes on its sector expertise by carrying out projects in collaboration with key research consortia, including industry, universities, research groups, public services and other departments and governments

Key 2008–2009 Achievements

- Working with industry partners, CanmetENERGY prepared and delivered a course called Integrating Distributed Generation: *Theory, Experience and Best Practices*. This course bridges the gap in knowledge by relating theory through the use of illustrative case studies. Integrating renewable and distributed power generation projects from independent power producers in Canada requires a change in the way the electricity distribution system is managed. And the integration must be done ensuring the safety, reliability and efficiency of the system and ensuring that local utility customers are not adversely affected.
- Working with the CSA, NRCan provided the technical support for the development of a second national interconnection standard: CSA C22.3 No. 9, "Interconnection of distributed resources with electricity supply systems – Interconnection of distributed resources to electricity supply systems up to 50 kV." This standard complements an earlier national standard NRCan helped develop and is helping advance the deployment of distributed electricity sources across Canada.
- CanmetENERGY, in cooperation with Advanced Engine Technology Ltd., Kubota Canada Ltd. and Cummins Onan, developed a 6 kilowatt-electric (kWe) natural gas-fuelled diesel engine for micro-cogeneration applications. Compared with 100 percent diesel operation, nitrous oxide emissions were reduced by 60 percent and CO_2 emissions by more than 12 percent. Rugged, heavy-duty diesel engines fitted with asynchronous generators can create a high-efficiency, long-life micro-cogeneration system at about half the cost of currently available micro-cogeneration systems. As a result of this work, the Saskatchewan Research Council is planning further testing to advance the system toward commercialization.
- CanmetENERGY hosted the First International Conference and Workshop on Micro-Cogeneration Technologies and Applications in cooperation with the International Energy Agency (IEA) and industry partners. The successful conference and workshop, attended by 98 delegates from 14 countries in Europe, Asia and North America, was an excellent forum for technology transfer and international collaboration. The event also served as the final communication exercise for the IEA Annex 42 on micro combined heat and power (micro-CHP) modelling and simulation.
- CanmetENERGY carried out preliminary studies on a micro-cogeneration technology utilizing Stirling engine technology supplied by Whisper Tech Limited of New Zealand. Testing was done at the Canadian Centre for Housing Technology and at the CanmetENERGY laboratories in

Ottawa, and residential pilots were initiated in Calgary, Ottawa and Toronto. Each pilot system generates electricity, produces domestic water heating and contributes heat for space heating. Each project demonstrates a different type of space heating integration, including a single-family detached home with radiant floor heating, a townhouse with multizone forced-air heating with a geo heat pump and a duplex with multizone forced-air heating with partial radiant heat floors.

- NRCan supported the first installation of the Honda Motor Co., Inc.-Climate Energy, LLC system in a Canadian home. The project will help bring this technology to Canada with NRCan advancing the codes and standards necessary. Long-term data collection will identify the benefits of this micro-cogeneration system, which include offsetting a homeowner's electrical costs by up to 60 percent while providing year-round domestic hot water and seasonal space heating. The project will deliver a green co-generation solution with an overall efficiency of approximately 90 percent that replaces the current residential space and water heating systems and adds backup power. The micro-CHP system is powered by natural gas with only approximately 0.3 kilograms (kg) of CO_2 emissions per kilowatt hour (kWh), whereas a coal-fired power plant emits approximately 1.1 kg/kWh of CO_2.

- CanmetENERGY worked with Acumentrics Canada in Kingston, Ontario, to support performance testing of a 1-kW test stand that operates with natural gas, hydrogen or anhydrous ammonia. This project could lead to a new paradigm for distributed energy in which carbon can be captured on a large scale, economically, as part of the manufacturing of the fuel. The resulting carbon-free fuel can then be used to generate electricity locally, at efficiencies rivalling the best large-scale power plants.

- The industry-led, government-supported Wind Technology Roadmap exercise identified key technical issues and action items for the increased deployment of wind energy in Canada. CanmetENERGY managed and provided technical expertise into consultations and workshops that benefited from the input of over 75 industry, academic and government stakeholders. The resulting roadmap document is an important tool in strategic planning for industry and government.

- CanmetENERGY commissioned and released the first pan-Canadian study of Canadian marine energy technologies, representative international technologies and Canada's research and development capacity within this emerging industry. The report provides policy makers, decision-makers and other stakeholders with baseline information on Canada's ability to compete in the marine energy technology market.

- CanmetENERGY research in micro-cogeneration led to an agreement between Ottawa-based Advanced Engine Technology Ltd. and the Saskatchewan Research Council to develop a micro-cogeneration system for small businesses, farms and multi-unit residential buildings. This distributed generation system will allow users to safely generate their own electricity, on- or off-grid, while also providing heat. Micro-cogeneration will displace coal-based electricity by using clean natural gas, help unload the power grid in critical areas or at critical times of the day and increase overall energy efficiency by a factor of nearly three.

For more information:

canmetenergy.nrcan.gc.ca/eng/clean_fossils_fuels.html

canmetenergy.nrcan.gc.ca/eng/renewables.html

CLEAN ENERGY SYSTEMS FOR INDUSTRY

Objective

To identify, encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, practices, products, systems and equipment in Canadian industry to improve its energy efficiency, productivity, competitiveness and profitability, while reducing GHG emissions and other environmental impacts.

Description

CanmetENERGY works with industry to co-manage and share the costs of development and commercialization of a range of technologies, including process integration, learning-based expert systems, combustion systems and controls, manufacturing processes, and environmentally friendly and energy-efficient processes for energy-intensive industries. CanmetENERGY's S&T in the industry sector focuses on plant-wide industrial process analysis techniques and advanced process control systems that identify and correct inefficiencies in plant operation and design while taking into account energy, economic and environmental aspects.

CanmetENERGY's S&T also includes the development and testing of semi-pilot-scale plants, pilot plants, prototypes and full-scale field trials. This research evaluates operating performance, energy efficiency and environmental impacts and emerging concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. In addition, CanmetENERGY disseminates technical information to encourage adoption of these techniques and practices in targeted energy-intensive sectors of Canadian industry.

CanmetENERGY clients are from a variety of industries, including pulp and paper, gas, oil upgrading and refining, petrochemicals, engine manufacturing, steel, chemicals, food and drink, solid wood, waste oil recycling and rendering, and specialty ceramic manufacturing. Its other clients are gas and electric utilities, equipment manufacturers and other governments.

Key 2008–2009 Achievements

- CanmetENERGY research engineers developed a decision-support tool for lumber mills in partnership with Laval University, Québec, Quebec. Lumber-mill production managers can now use this software tool to better plan air-drying operations before kiln drying, with a future impact of improving overall mill energy efficiency and product quality. AbitibiBowater Inc. recently deployed this tool to better plan its sawmills' operations, including shipping lumber between mills throughout the country.

- CanmetENERGY and its partner, Acumentrics of Kingston, Ontario, have modified a hydrogen fuel cell by adding a catalytic surface developed at CanmetENERGY and operating the fuel cell on ammonia. The catalyst performed as well as at the bench scale, and there were no ammonia or nitrous oxide emissions. Ammonia fuel cells can take advantage of the large amount of ammonia currently being incinerated in industrial wastewater treatment. As well, the industrial production of ammonia creates pure CO_2. Ammonia is also an industrial and agricultural product with some infrastructure capacity.

- CanmetENERGY supported the renewal of the NSERC Chair in Environmental Design Engineering in co-operation with the Natural Sciences and Engineering Research Council of Canada (NSERC), Kruger Inc., White Birch Paper Company, Papier Masson Ltd., NewPage Corporation, Cascades Canada, Ltd,. Tembec

Inc. and the École Polytechnique de Montréal. Cost-effective and energy-efficient designs for the pulp and paper industry will be developed through this collaborative research program.

- CanmetENERGY has signed an agreement with NOVA Chemicals Corporation to undergo an energy-efficient retrofit of two of its largest olefin production facilities. This work features the development and application of a new thermodynamically based design methodology for distillation process debottlenecking through hybridisation with advanced separation technologies.

- CanmetENERGY established a five-year collaboration with the Agence de l'efficacité énergétique to help Quebec industrial facilities maximize heat recovery and reduce their petroleum products use and corresponding air emissions cost-effectively. These improvements will be achieved through the use of a plant-wide energy management approach called process integration. This collaboration includes activities to expand the capacity of Quebec engineering firms to undertake global energy analyses in order to uncover substantial efficiency gains.

For more information:
canmetenergy.nrcan.gc.ca/eng/industrial_processes.html

ENVIRONMENTALLY SUSTAINABLE OIL AND GAS

Objective

To provide S&T for the continued, secure supply of affordable, cleaner, and more efficient fossil fuels, with little or no adverse environmental impact on GHG and Criteria Air Contaminants (CAC) emissions, and thereby help resolve oil sands environmental issues (including water) and clean air issues for the upstream oil and gas industry.

Description

CanmetENERGY conducts fundamental and applied research to develop knowledge and implement leading-edge technologies for the oil sands sector. Knowledge gained is used to inform energy policy development and industry decisions that will improve the quality of life for Canadians.

CanmetENERGY fosters innovation in oil sands and heavy oil technology through activities ranging from fundamental science to commercial-scale technical support. CanmetENERGY's strength lies in its staff's fundamental understanding of the chemistry, physics and engineering of oil sands and heavy oil processes, coupled with sophisticated analytical instrumentation and pilot-scale units providing proof of concept for technologies.

S&T is a key tool used by NRCan to make significant progress toward meeting its water and tailings, GHG and other air emissions challenges in the oil and gas sector. Major improvements need to be made in the entire process chain of oil sands and heavy oil development, from the initial extraction to the production of petroleum products.

CanmetENERGY's international client base and partnerships with provincial and territorial governments, industry and academia ensure that the best available technologies in the world can be applied to the resource. Its partnerships also ensure there are strong synergies and fast-track deployment of new technologies, innovations and knowledge dissemination.

Key 2008–2009 Achievements

- CanmetENERGY, in collaboration with the U.S. Department of Energy's National Renewable Energy Labs (Oakridge National Lab and Pacific North-West Lab), is working to increase the value of Canadian bitumen. Activities included the employment of both conventional

and newly developed techniques for the characterization of hydrocarbon streams. This characterization is essential for evaluating the suitability of fuels for advanced combustion engines. CanmetENERGY scientists identified deficiencies in current chemistry analysis of diesel fuel, specifically, the need for advanced two-dimensional gas chromatography. As a result, the U.S. Department of Energy (U.S DOE) is expanding its efforts to understand the influence of fuel chemistry on the effectiveness of modern engines.

- In the attempt to demonstrate a tailings technology that will reduce the water requirements for producing a barrel of oil, CanmetENERGY conducted the first field tests of the dry stackable tailings at Syncrude's oil sands mine.

- In anticipation of the impact California's low-carbon fuel standards will have on Canadian bitumen, CanmetENERGY completed a life-cycle analysis on oil sands-derived fuels. CanmetENERGY, in collaboration with Petroleum Technology Alliance Canada, organized a workshop on a fuel-cycle model called U.S. DOE Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation. Subsequently, two studies funded by the Alberta Energy Research Institute were initiated as a result of this workshop.

- CanmetENERGY, through the National Centre for Upgrading Technology, has worked with a small enterprise, ETX Systems Inc., to provide a proof of concept for a new upgrading technology that reduces the negative environmental impact while producing higher quality liquids compared with existing benchmarks.

For more information:
canmetenergy.nrcan.gc.ca/eng/clean_fossils_fuels.html

CLEAN TRANSPORTATION ENERGY

Objective

To develop and deploy, in partnership with industry, academia and the provinces and territories, leading-edge hydrogen, fuel cell and transportation energy technologies that reduce GHG emissions and minimize urban air pollution.

Description

CanmetENERGY works with stakeholders in domestic and international hydrogen and transportation industries. These industries include original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. DOE, the International Energy Agency and the International Partnership for the Hydrogen Economy. Together, in these partnerships, projects are well leveraged – typically at a 50:50 ratio.

Transportation research, development and deployment activities at CanmetENERGY are grouped into three principal technology areas: hydrogen and fuel cells, hybrid and electric vehicles, and advanced fuels and technologies. All three technology areas are highly involved in domestic and international outreach, and safety, codes and standards for technology adaption and integration.

Since the early 1980s, CanmetENERGY's partnerships with industry have been playing a significant role in establishing Canada as a world leader in fuel cell and hydrogen-refuelling technologies.

Today near-term accomplishments are being made in the transportation and materials handling sectors. Research and development in production, storage and utilization continue to lower costs and improve the performance of the hydrogen technologies. Hydrogen fuelling stations and hydrogen-powered

forklifts, airport baggage-tuggers, personal vehicles and shuttle buses continue to be deployed across Canada. In addition to vehicles and fuelling stations, developments in waste hydrogen capture and purification, production, distribution and storage are building the hydrogen infrastructure.

As well, applications in markets outside the transportation sector are being realized, such as micro fuel cells/portable applications (e.g. laptops and cellular phones) and stationary applications (e.g. off-grid and backup power for computers and buildings).

Electricity as an alternative transportation fuel is also becoming a near-term reality for Canada. Hybrid and electric vehicle technologies offer energy-saving advantages over current vehicle technologies that run solely on conventional fuels such as gasoline or diesel.

CanmetENERGY is involved in research and development of on-board energy-storage and power systems, such as batteries and fuel cells. In 2008, CanmetENERGY took on the Government of Canada lead for the *Electric Vehicle Technology Roadmap for Canada*, which it completed in 2009.

Advanced fuels and technologies encompass all fuels and technologies in addition to hydrogen and fuel cells and hybrid and electric vehicles – examples are biodiesel, natural gas and ethanol. CanmetENERGY supports research and development for testing advanced fuels and fuel usage, as well as engine performance and components.

This area of research and development is serving to strengthen a Canadian industry that is now exporting commercial products. International collaborative efforts are helping to leverage Canada's research funding – particularly for the evaluation of fuels and hardware performance and in developing standards.

Key 2008–2009 Achievements

Research and Development

- A hydrogen and fuel cell laboratory was established at CanmetENERGY's Bells Corners Complex in Ottawa, Ontario. The lab is now fully operational for processing and characterizing new materials for fuel cells and nanomaterials for storage. The CanmetENERGY lab will provide research expertise to external partners and access to unique facilities to meet joint technical targets.

- A prototype lightweight hydrogen storage energy pack was developed through a CanmetENERGY partnership with Angstrom Power Inc. The prototype hydrogen storage unit is the same size as four D-cell batteries but offers nearly 50 percent greater energy density and run-time compared with the current D-cell battery technology. This prototype development strengthens the competitive advantages of hydrogen and fuel cells over batteries for portable applications.

- CanmetENERGY supported Hyteon Inc. to develop a new fuel cell-powered combined heat and power (CHP) system. This CHP system uses high temperature proton exchange membrane fuel cell technology to generate electricity and heat for residential applications. When combined with a common heat exchanger, residual heat from the CHP system can be used to heat domestic water. This new CHP system significantly improves operation efficiency and is made from low-cost, lightweight materials. Fuel-cell CHP systems present a viable option to reduce natural gas use.

- CanmetENERGY contributed to the development of the Directory of Electric Mobility Resources for Canada. The directory will assist the entire electric vehicle community, including government agencies, academic institutions and the private sector, in finding the right resources

to forge partnerships and to increase business development. The directory is available to the public from the Electric Mobility Canada Web site at www.emc-mec.ca.

- Through NRCan expertise, the ISO 1611 standard was published under a United Nations subcommittee that deals with the transportation of dangerous goods. Prior to this standard, shipping hydrogen storage assemblies was very costly and time consuming. This standard makes this process much more efficient because ISO 1611 sets the basic requirement for the safe shipment of hydrogen stored in metal hydride assemblies.

Demonstration

- Four stationary fuelling stations and one mobile fuelling station are operating in British Columbia as part of the Hydrogen Highway™. The five Ford Focus fuel-cell cars successfully completed their fourth year of on-road testing and evaluation in the Vancouver and Victoria areas, accumulating 270 000 kilometres of use.

- Two Ford hydrogen internal combustion engine shuttle buses, along with their hydrogen fuelling infrastructure, have been running successfully in regular transit in Charlottetown, Prince Edward Island. Field testing of the buses has collected data on the viability of these technologies, and more than 50 first responders were trained on hydrogen safety. Hydrogen produced from wind power at North Cape will be integrated next year. This project demonstrates utilization of hydrogen and renewable energy in the transportation sector.

- In 2008, CanmetENERGY was involved in two demonstrations programs supporting the mandate proposed by the Government of Canada of a 2 percent annual average renewable diesel content in the Canadian diesel pool by 2012. CanmetENERGY provided technical expertise for the Alberta Renewable Diesel Demonstration – Canada's largest cold-weather study of renewable diesel fuels. The program successfully demonstrated the on-road use of low-level renewable diesel blends in a range of Canadian climatic conditions. CanmetENERGY also helped design the program structure for the National Renewable Diesel Demonstration Initiative and continues to provide technical advice to the program.

For more information:
canmetenergy.nrcan.gc.ca/eng/transportation.html

SUSTAINABLE BIOENERGY

Objective

To assist Canadian industry in the R,D&D of bioenergy technologies, thereby increasing the production and use of bioenergy, which generates environmental and economic benefits.

Description

CanmetENERGY supports the R,D&D of bioenergy technology through cost-shared agreements, promotes bioenergy as a renewable and sustainable energy source, advocates the need for proper policies and programs relating to bioenergy, and raises the public's and policy makers' awareness of the benefits of bioenergy.

CanmetENERGY's biomass energy conversion technology expertise covers the following main processes:

- combustion – converting forestry, agricultural and municipal residues into heat and power under environmentally sound conditions

- gasification – converting forestry, agricultural and municipal residues into syngas

- pyrolysis – converting forestry and agricultural residues into bio-oils and value-added products

- fermentation – converting the starch and cellulose components in biomass into bio-ethanol

- transesterification – converting a variety of new and used vegetable oils, tallow and yellow grease into bio-diesel

- anaerobic digestion – converting manures and food-processing and municipal wastes into methane-rich biogas

Activities focus on improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry demonstrate its products in domestic and foreign markets.

Initiatives include R,D&D, technical and socio-economic studies, end-use demonstrations and testing, feasibility studies, process analysis, verification, testing and improvement, standards development, emissions reductions, modelling, conference and workshop support, information dissemination, International Energy Agency collaboration and committees, stakeholder education, and standards development.

CanmetENERGY plays a leadership role in the Canadian Biomass Innovation Network, a multidepartmental working group formed to direct federal R&D on bioenergy and bioproducts. Clients include the agricultural and forestry sectors (biomass producers and bioenergy consumers), municipalities and industrial partners.

Key 2008–2009 Achievements

- Several energy technologies are being fast-tracked through the National Bioproducts Program, a joint initiative of National Research Council Canada (NRC), Agriculture and Agri-Food Canada (AAFC) and CanmetENERGY. One of these is the production of renewable diesel fuel from marine algae, which is based upon R&D performed by NRC on the selection and growing of algae, combined with CanmetENERGY R&D researching the conversion of the algae oil and residue to energy products. Another technology is based on NRC and AAFC developing crops that produce residues suitable for conversion to energy products in CanmetENERGY's pilot facilities, a technical challenge based on the wide variation of feed properties and the production of heat and power consistent with industrial and commercial expectations.

- CanmetENERGY is working with the producers of wood pellets and power utilities to develop the codes and standards needed to safely and efficiently burn wood pellets in existing coal-powered generating stations. The issues to be addressed include the different flammability properties of wood pellets compared with coal and how to control the ash. Utilities are planning to switch fuels from conventional coal to biomass and are relying on these codes and standards for their planning.

- CanmetENERGY has joint initiatives with provincial departments of agriculture on helping greenhouses adjust to the high cost of natural gas by developing the control technologies to burn biomass. This initiative includes developing a biomass fuels protocol that includes a database of biomass residues properties and guidelines for emissions standards. R&D activities include the development of optimized controls for biomass boilers and flue gas cleaning so that CO_2 can be used in the greenhouses to encourage growth.

For more information:
canmetenergy.nrcan.gc.ca/eng/bioenergy.html

CANADIAN BIOMASS INNOVATION NETWORK

Objective

To develop sustainable and cost-effective technologies in bioenergy, biofuels, bioproducts and industrial bioprocesses for market acceptance while utilizing biomass resources in a sustainable and responsible way.

Description

The Canadian Biomass Innovation Network (CBIN) supports strategic R&D in bioenergy, biofuels, bioproducts and industrial bioprocesses to reduce fossil fuel energy consumption, directly or indirectly reduce GHG and CAC emissions, diversify the energy supply and seed the development of Canada's bio-based economy.

CBIN is a horizontal program developed and managed by five departments: AAFC, Environment Canada, Industry Canada, NRC and NRCan. CBIN coordinates and manages two federal government bio-based R&D initiatives:

- the PERD Bio-Based Energy Systems and Technologies program ($3.3 million in 2008–2009)
- the ecoENERGY Technology Initiative Bio-Based Energy Systems ($2.2 million in 2008–2009)

Key 2008–2009 Achievements

- NRCan funding promotes the better utilization of fast-growing plantations as part of new sustainable forest management strategies being developed across Canada. It also increases social pressure to manage native forests in a sustainable and ecological manner, which reinforces the necessity of developing alternatives to traditional forestry (i.e. harvesting natural forests).
- In 2008, the Quebec department of agriculture (le ministère de l'Agriculture, des Pêcheries et de l'Alimentation) recognized all energy-dedicated crops, including short-rotation plantation/agroforestry systems, as agricultural crops. This change was supported by the findings of two reports funded by the Technology and Innovation Research and Development Initiative, and will grant Quebec producers of short-rotation woody biomass a legal status similar to that of farmers, with the associated financial benefits.
- A new type of woody crop harvester was developed by AAFC through the previous Technology and Innovation Research and Development Initiative. The prototype, called the "bio-baler" (patent pending in Canada, the United States and Brazil), was based on a modified conventional agricultural baler. This high-efficiency, high-volume biomass compactor and baler is versatile and powerful. It transforms vegetal and woody biomass into compressed round bales designed for industrial use. This innovative equipment has the potential to accelerate the availability of woody crops from various land types, including marginal and fallow fields. It is both less expensive and more effective than conventional technologies.
- Combustion testing of municipal biosolids at an NRCan lab provided the performance and environmental data required by the City of Buffalo, Minnesota, to install a combustor from KMW Energy Inc. of London, Ontario, in its wastewater treatment facility. Since its successful start-up, the facility has received an engineering award from the Minnesota American Council of Engineering Companies.

For more information:
www.cbin.gc.ca

CHAPTER 5

Renewable Energy

RENEWABLE ENERGY USE

In 2007, renewable sources accounted for approximately 62 of Canadian installed electricity capacity (see Table 5-1). Most of the renewable energy used in Canada comes from either hydroelectricity or thermal energy from biomass, such as wood-waste sources (see Table 5-2).

TABLE 5-1

Electricity Generation Capacity From Renewable Sources (includes hydroelectricity)

Year	Renewable electricity generation capacity (megawatts)	Total capacity (percent)	Percent change
1990	59 557	58	–
1991	61 116	58	3.0
1992	62 895	58	2.9
1993	63 114	56	0.3
1994	63 175	56	0.1
1995	66 542	57	5.3
1996	67 101	59	0.8
1997	68 202	61	1.6
1998	68 340	62	0.2
1999	68 614	61.8	0.4
2000	69 031	62	0.6
2001	68 845	61.2	-0.3
2002	71 032	61.8	3.2
2003	72 275	61.8	1.7
2004	72 947	60.4	0.9
2005	74 368	61.2	1.9
2006	75 812	61.3	1.9
2007	76 890	61.8	1.4

Source: Statistics Canada, Electric Power Generating Stations (Cat. No. 57-206-XIB).

TABLE 5-2

Renewable Energy Markets and Technologies Used in Canada

Electricity – Commercial	**Mechanical Power**
Hydroelectric dams	Wind water pumps
Tidal barrages	
In-stream current devices	**Thermal Energy**
Biomass (e.g. wood waste)	Biomass (e.g. roundwood, pellets, wood chips)
Biogas (e.g. methane from landfill sites)	Ground-source heat pumps (i.e. earth energy)
Wind turbines	Solar air-heating systems
Photovoltaic systems	Solar hot water systems
Electricity – In development	**Transportation**
Wave systems	Biodiesel
Tidal systems	Ethanol from biomass

Hydroelectricity

Hydroelectricity is a renewable form of electricity generated from a system or technology that uses a mechanical method to capture and convert the potential energy of water.

Hydro is the main source of electricity in Canada, accounting for 59 percent of the electricity generated in 2007. Canada's hydro supply is dominated by large-scale projects that were developed by electric utilities. Of the 72 436 megawatts (MW) of installed hydro capacity, 3301 MW come from small hydro sites (capacity less than 50 MW), equal to about 2.7 percent of Canada's total installed electricity capacity. Significant potential remains for additional hydroelectric development in most provinces and territories.

Biomass

Biomass provides a renewable source of energy derived from the conversion of matter from living organisms or metabolic by-products. Canada has an abundant supply of many types of biomass, which is important for the production of energy, biofuels, materials and chemicals. The two largest sources of biomass supply in Canada are forestry and agricultural operations.

Biomass supply typically takes the following forms:

- forestry – mill or pulp-and-paper residues, black liquor from the pulping process, forest residue, forest management thinnings and short rotation crops
- agriculture – agricultural crops, crop residue, processing residues, algae and aquatic biomass
- other organic waste – animal waste, such as manure from feed lots, municipal solid waste and industrial wastes

Approximately 4.6 percent of Canada's total energy supply comes from bioenergy, second only to hydro power (which generates 11.5 percent of Canada's energy). Most of the bioenergy produced is in the form of industrial process heat, electricity and residential space heating.

The pulp and paper industry is Canada's major producer and user of bioenergy. In 2007, more than 657 MW of biomass power came from spent pulping liquor used in the pulp and paper industry, representing approximately 42 percent of the total biomass generating capacity.

Heat and electricity produced by industry, electricity generated by independent power producers, and residential wood heat are considered commonplace in Canada's energy mix. For example, approximately 3 million Canadian households use wood for home heating. Roundwood is typically used but alternatives include wood chips and pellets. Wood for home heating is usually burned in stand-alone wood stoves, wood furnaces with hot water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters.

Use of biogas and landfill gas (methane-rich gases that are derived from manure, animal processing wastes, other agricultural residues and municipal waste) for energy production is just emerging.

In 2007, the biomass installed capacity was 1578 MW, of which approximately 10 percent was from landfill gas plants (119 MW) and municipal solid waste plants (35.7 MW). Approximately 200 million litres of fuel ethanol are produced annually in Canada from cereal grain and corn. Biodiesel is also produced in small quantities, but production is increasing. Canada has the potential to increase its bioenergy production in a sustainable manner.

Earth Energy

As a result of the sun heating the surface of the planet, and because of the insulating qualities of the earth itself, the temperature 1 or 2 metres below the surface remains fairly constant – between 5°C and 10°C. This temperature is warmer than that of the air during the winter and cooler than that of the air in the summer.

A ground-source heat pump takes advantage of this temperature difference by using the earth or groundwater as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, a ground-source heat pump is known as an earth energy system (EES).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution or water that circulates within an underground loop. The EES then upgrades the heat with a conventional heat pump and transfers it to

indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with potential estimated at more than 100 000 MW.

As of December 31, 2008, 2369 MW of wind power were installed in Canada. This makes Canada the thirteenth country that has reached the 1000-MW milestone and the country with the twelfth-largest installed wind energy capacity.

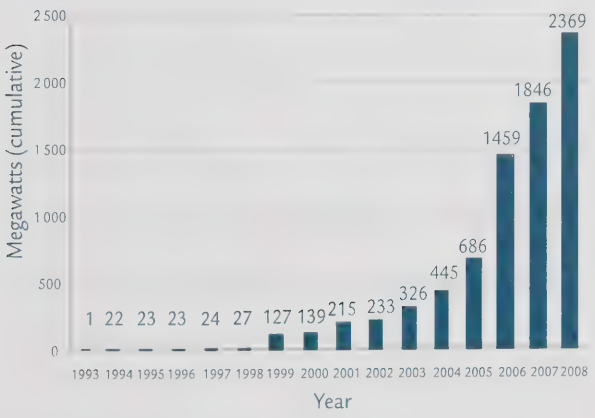
In 2008, Canadian wind power grew to 2369 MW – a 28 percent increase from the 2007 level (1846 MW) (see Figure 5.1). Proposals to build Canada's first offshore wind farms on submerged lands near British Columbia and in Lake Ontario are proceeding through the permitting stage.

Federal and provincial policies continue to spur growth in the Canadian wind industry. Wind energy accounted for approximately 1.1 percent of Canada's total electricity generation in 2008, up from 0.9 percent in 2007.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

FIGURE 5-1

Canadian Wind Power Capacity, 1993 to 2008



Source: Canadian Wind Energy Association.

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies – buildings are designed and located to maximize their reception of solar energy
- active solar thermal systems – solar radiation is converted into thermal energy for heating air or water in residential, commercial and industrial applications
- solar electric (photovoltaic [PV]) systems – solar radiation is used to produce electricity

The Canadian active solar thermal installed capacity in 2007 was 544 000 square metres (m^2), or 380 $MW_{thermal}$. The domestic market increase has averaged 13 percent annually since 1998. In 2007, the solar thermal collector market in Canada was 60 900 m^2, compared with 61 800 m^2 in 2006, but revenues were up by 7 percent. This is likely due to increased domestic sales of glazed and evacuated tube collectors and reduced sales of unglazed air heating collectors in this period.

Canada's PV installed capacity in 2007 was 25.8 MW, with a sustained unsubsidized domestic market growth that has averaged 25 percent annually since 1992. In 2007, the PV module market in Canada was 5.92 MW, compared with 3.75 MW in 2005.

Ocean Renewable Energy

Ocean renewable energy refers to the use of ocean waves, current and tides to generate electricity. Devices that capture ocean or tidal currents can also be deployed in rivers and streams.

Since 1984, Canada has had the only commercial tidal energy facility in North America – the 20-MW plant in Annapolis, Nova Scotia. However, like wave and current devices, the next generation of tidal power generators is in an early stage of development, and as yet no commercial facilities have been proposed.

Canada is well poised to become a leader in global technology development and deployment. Canadian technology developers are planning and testing devices, and several demonstration projects are underway.

Natural Resources Canada carries out two initiatives to increase the use of renewable energy in Canada: ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat. The two programs are outlined below.

ecoENERGY FOR RENEWABLE POWER

Objective

To encourage the production of 14.3 terawatt hours (TWh) of electricity from low-impact renewable energy sources (about 4000 MW of new capacity), such as wind, hydro, biomass, solar PV and ocean energy, between April 1, 2007, and March 31, 2011.

Description

The ecoENERGY for Renewable Power program provides an incentive of one cent per kilowatt hour to an eligible low-impact renewable energy project for up to 10 years. Eligible recipients include businesses, institutions/organizations, independent power producers, public and private utilities, and co-operatives that install qualifying renewable power systems. Qualifying projects must have a total rated capacity of 1 MW or greater.

Key 2008–2009 Achievements

- At March 31, 2008, 52 contribution agreements were signed with proponents, representing about $900 million in federal funding over 10 years and 2700 MW of renewable power capacity.
- After all 52 projects are commissioned, the expected greenhouse gas (GHG) emission reductions from full-year operations are expected to be about 4.2 megatonnes per year.

For more information:
ecoaction.gc.ca/ecorp

ecoENERGY FOR RENEWABLE HEAT

Objective

To increase the use of renewable energy technologies, develop thermal energy industry capacity and contribute to the reduction of harmful emissions. This four-year program was launched April 1, 2007.

Description

The ecoENERGY for Renewable Heat program supports renewable thermal technologies used for space heating and cooling and water heating, through a mix of deployment incentives, residential pilot projects and industry capacity-development funding:

- deployment incentive – providing a financial contribution to encourage the deployment of solar thermal units in the industrial, commercial and institutional sectors

- residential pilot projects – providing financial contributions to test, through collaborative ventures, various approaches to for the deployment of solar water-heating units in the residential sector

- industry capacity-development – providing financial contributions to develop technology standards, certification procedures for solar thermal technologies, human resources skills and tools for renewable thermal technologies and to provide public information on renewable thermal energy technologies

Key 2008–2009 Achievements

- Installed 297 solar thermal systems in the industrial and commerical/institutional sectors.

- Signed contribution agreements with 11 partners (utilities, developers and buyers' groups) to run pilot projects that will test ways to deploy solar-heated water in the residential sector. Under the pilot projects, up to 6100 solar water-heating systems will be installed in Canadian homes by 2010.

- Established a partnership with one provincial government, bringing the number of arrangements with provincial governments for complementary programs to three.

- Entered into partnerships with two renewable energy industry associations and two other groups to improve training and certification of solar and geoexchange industry professionals.

- Nine contribution agreements were signed with companies for the certification of solar domestic packaged water-heating systems.

- The estimated GHG reduction from systems installed under the program during 2008–2009 is expected to be 5.5 kilotonnes (kt). After including the GHG reductions from projects completed in 2007–2008, program's estimated cumulative GHG reductions are 8.8 kt.

For more information:
ecoaction.gc.ca/heat

CHAPTER 6

Co-operation

INTRODUCTION

This chapter describes Natural Resources Canada's (NRCan's) co-operation with provincial and territorial governments and internationally on efficiency and alternative energy (EAE) during the reporting period. Examples of program co-operation on specific EAE initiatives are in the "Key Achievements" sections in earlier chapters.

Municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (e.g. in idle-free projects).

At the same time, NRCan participates in ventures led by municipal organizations, such as the Green Municipal Fund (see accompanying textbox), and by provincially and territorially regulated electricity utilities and provincially regulated natural gas utilities.

Several institutions in Canada address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies, and various associations and energy supply utilities. Their main objectives are to facilitate access to data on energy use in the industry, transportation and building sectors; monitor the quality of data; and investigate methods of improving data collection and analysis.

There are two national consultative bodies in the area of energy efficiency: the Assistant Deputy Minister Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers; and the Office of Energy Efficiency's (OEE's) National Advisory Council on Energy Efficiency (NACEE).

Green Municipal Fund

The Government of Canada endowed the Federation of Canadian Municipalities (FCM), a non-profit organization, with $550 million to establish the Green Municipal Fund (GMF) for the purpose of providing a long-term, sustainable source of funding for municipal governments and their partners. The GMF invests in plans, studies and projects that offer the best examples of municipal leadership in sustainable development and that can be replicated in other Canadian communities.

Under the GMF agreement, the Government of Canada (represented by NRCan and Environment Canada) participates in governance of this revolving fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council.

The FCM board of directors approves projects in light of the council's recommendations. As of March 31, 2009, the GMF had approved more than $402 million for 735 plans, studies and projects with a total project value of $2.6 billion.

ASSISTANT DEPUTY MINISTER STEERING COMMITTEE ON ENERGY EFFICIENCY

In 2004, federal, provincial and territorial energy ministers established the ASCEE and tasked it with establishing a coordinated, complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held three meetings in the 2008–2009 fiscal year, with members representing the federal, provincial and territorial governments.

There are three working groups under the auspices of the ASCEE. In 2007, these groups contributed to the development of the Council of Energy Ministers' document *Moving Forward on Energy Efficiency in Canada: A Foundation for Action*.

Responding to Ministers' direction, the three ASCEE working groups are undertaking actions to develop concrete energy efficiency initiatives based on the themes and ideas in *Moving Forward on Energy Efficiency in Canada*. These may be delivered by multiple jurisdictions and in conjunction with key stakeholders.

- Formed in 2003, the Demand Side Management Working Group (DSMWG) has members representing NRCan, industry and all provinces and territories. DSMWG has subcommittees performing collaborative tasks in the following areas:

  - *National Energy Code for Buildings*
  - building energy benchmarking
  - commissioning and recommissioning of buildings
  - energy-efficient equipment
  - integrated community energy solutions
  - lower-income-household energy efficiency options
  - accelerated penetration of energy-efficient home retrofits

- The ASCEE sponsored the formation of the Transportation Working Group on Energy Efficiency (TWGEE) in 2005. Its mandate is to assess the status and enhance the alignment of transportation energy efficiency activities across federal, provincial and territorial jurisdictions and to investigate opportunities for further collaboration and new initiatives. The TWGEE comprises government officials from federal, provincial and territorial energy and transportation departments and ministries. In the 2008–2009 fiscal year, TWGEE members worked to identify four technology areas affecting heavy-duty intercity transport trucks that have the potential to improve fuel efficiency and thereby reduce greenhouse gas emissions. These areas are aerodynamics, idle reduction, low-rolling resistance tires and long-combination vehicles. Work is underway to develop collaborative actions that may be undertaken by federal, provincial and territorial governments in the first three technology areas.

- The Industry Working Group on Energy Efficiency was formed in 2006. It promotes information exchange among industrial energy end-users and authorities, agencies, utilities and jurisdictions involved in the design, development and delivery of industrial energy efficiency programming in Canada.

NATIONAL ADVISORY COUNCIL ON ENERGY EFFICIENCY

NACEE was created in April 1998 to assist the OEE as an innovative government organization by

- assessing and advising on the OEE's strategic approach to meeting federal policy objectives

- advising the OEE on its performance and business planning and reporting on progress

- considering issues related to accelerating growth in energy efficiency in the Canadian economy

NACEE membership is drawn from across Canada. It includes representatives from various levels of government, academia, economic sectors, energy utilities and advocacy groups. NACEE met three times during the 2008–2009 fiscal year.

FEDERAL-PROVINCIAL AND FEDERAL-TERRITORIAL CO-OPERATION

Interest continues to grow in energy efficiency as a means of maximizing services based on the existing energy supply capacity in the country. In addition to general co-operation on energy efficiency, provincial and territorial governments helped to deliver tools, or employed tools provided by federal EAE programs, to reduce energy costs, address climate change, increase competitiveness, improve air quality and create economic opportunities. Coordination between the federal and provincial/territorial levels avoids duplication and ensures efficient program delivery.

All provinces and territories engage in energy efficiency activities and/or deliver energy efficiency programs in their jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency.

For example, one of the objectives of Alberta's Climate Change Central is to focus on information and action on energy efficiency and conservation in the province.

The Office of the Fire Commissioner of Manitoba is engaging stakeholders in a review of the Energy Code Advisory Committee recommendations, the introduction of water efficiency in the plumbing code and the identification of barriers in the *Manitoba Building Code* to energy and water efficiency in buildings.

The Ontario Power Authority's Conservation Bureau provides leadership in planning and coordinating measures for electricity conservation and load management.

The Canada-Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power.

Recently, there has been a greater focus on energy efficiency in the Maritime provinces, as evidenced by the creation of three agencies: Efficiency NB, Conserve Nova Scotia and Prince Edward Island's (P.E.I.'s) Office of Energy Efficiency.

Efficiency NB's mandate is to promote efficient energy use, help control energy expenses and lessen the impact of energy use on the environment, while P.E.I.'s Office of Energy Efficiency provides advice and programs to promote sustainable energy use.

Other regional organizations of note are the Arctic Energy Alliance in the Northwest Territories, the Nunavut Energy Centre and the Agence de l'efficacité énergétique du Québec.

Use of Federal EAE Program Tools by Utilities, Provinces and Territories

Provincial and territorial governments and utilities use federal EAE program tools to complement their own energy efficiency programs. Here are some examples:

- Homeowners in all regions of Canada, except one province and one territory, can access both provincial/territorial and federal home retrofit programs through a single energy evaluation offered under ecoENERGY Retrofit – Homes. The ecoENERGY evaluation and its criteria are also used by these jurisdictions to determine eligibility for incentives.

- Canadians in most provinces and territories can benefit from rebates and sales tax exemptions on selected ENERGY STAR® products. The ENERGY STAR program is administered by the OEE and is used by a number of provinces and utilities as a qualifying criterion.

- NRCan's R-2000 Standard is used by utilities in Manitoba, New Brunswick, and Nova Scotia as a qualifying criterion for incentives and rebates designed to encourage the construction of energy-efficient new homes.

- All the provincial and territorial bodies (with the exception of Nunavut) responsible for driver education use the Auto$mart Driver Education Kit, developed by the OEE, to educate young drivers on fuel efficiency. For example, Manitoba Public Insurance has recently incorporated an Auto$mart component into its curriculum, and many provinces display the OEE's publications in their licensing bureaus.

- The OEE works in co-operation with many provincial organizations, such as Conserve Nova Scotia, to fund and implement actions to reduce energy use and greenhouse gas emissions from personal vehicles by improving the buying, driving and maintenance practices of Canadians.

The Building Energy Codes Collaborative

The Building Energy Codes Collaborative (BECC) is a provincial-territorial-federal committee supported by the Council of Energy Ministers, ASCEE and NRCan. BECC is made up of representatives from provincial/territorial code and energy ministries, departments and agencies; NRCan; and the Canadian Codes Centre. The objectives of the BECC are as follows:

- provide a forum for provinces, territories and the federal government to support the update, regulatory adoption and implementation of the *Model National Energy Code for Buildings* (MNECB), which is now called the *National Energy Code for Buildings* (NECB), by responsible authorities

- work in co-operation with the provinces and territories and the Canadian Commission on Building and Fire Codes toward a national consensus on establishing energy efficiency in the code process

- explore other regulatory and/or program instruments for increasing energy efficiency in new housing, including updating the MNECB

- seek support from the federal government and the energy and building code ministries in the provinces and territories and engage their representatives in the process

NRCan and BECC prepared a business plan for updating the 1997 MNECB and presented it to the Canadian Commission on Building and Fire Codes. Commission members unanimously approved the following motion at its annual meeting in Calgary in February 2007: ". . . that the updating of the MNECB as a progeny document based on the BECC Business Plan be approved."

NRCan then prepared and signed a memorandum of understanding (MOU) with the National Research Council (NRC). NRCan is contributing up to $5 million over four years to support the

technical development of the new code and is providing technical expertise to the NRC team tasked with developing national codes. The NRC launched the project, and the Standing Committee on Energy Efficiency in Buildings held its first meeting on updating the code in Ottawa in December 2007.

The updated MNECB will be published by 2011 in an objective-based format. It will complement objective-based model national construction codes published in 2005.

Co-operation Agreements

NRCan's memorandum of agreement (MOA) on EAE with the Agence de l'efficacité énergétique du Québec provides for consultation and sharing of information between the two governments, the coordination of EAE activities in Quebec and the creation of opportunities for joint projects. Further, the management committee established under the MOA reviews policy and program developments, progress on joint program initiatives and areas for further co-operation. NRCan is working with the Agence de l'efficacité énergétique to deliver services under the ecoENERGY programs.

The MOA played a role in facilitating three activities in particular:

- management of the licensing agreement for local delivery of ecoENERGY Retrofit – Homes
- NRCan's Buildings Division's continued processing of payments for the former EnerGuide for Existing Buildings and Commercial Building Incentive programs under a letter of co-operation (LOC) with the Agence de l'efficacité énergétique that covers the 2007–2008 fiscal year and the 2008–2009 fiscal year. Though the two programs are closed, payments, which can be made only when the client proves to NRCan that work has been completed, are still being processed.
- management of an agreement on the Programme d'intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec ice rinks

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information sharing and the creation of opportunities for joint projects in Yukon.

These projects include the Canada–Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to technical services and programs for the Yukon population and undertakes outreach and public education activities.

NRCan works with the Office of the Fire Commissioner of Manitoba, a special operating agency of Manitoba Labour and Immigration, to engage Manitoba stakeholders in a review of the Energy Code Advisory Committee recommendations.

Manitoba is also consulting stakeholders on introducing water efficiency in the plumbing code and identifying barriers in the *Manitoba Building Code* to energy and water efficiency in buildings. The result will be a stakeholder consultation report provided to Manitoba's Minister of Labour and Immigration and Minister of Science, Technology, Energy and Mines.

NRCan works with Ontario's Ministry of Small Business and Consumer Services, the Independent Electricity System Operator and local distribution companies to provide energy management training to companies across Ontario through Dollars to $ense workshops.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a non-profit corporation funded by several stakeholders, including the Government of Alberta.

Sustainable Development Technology Canada – NextGen Biofuels Fund™

The NextGen Biofuels Fund™ is a $500-million program scheduled to run from 2008 to 2017. Responsibility for the program is held jointly by NRCan and Environment Canada. The fund is managed under the auspices of Sustainable Development Technology Canada (SDTC).

The NextGen Biofuels Fund™ aims to facilitate the establishment of first-of-a-kind, large, demonstration-scale facilities for the production of next-generation biofuels and co-products in Canada; improve the sustainable development impacts arising from the production and use of biofuels; and encourage retention and growth of technology expertise and innovation capacity for the production of next-generation biofuels.

Next-generation renewable fuels are derived from non-traditional renewable feedstocks – such as forest biomass, fast-growing grasses and agricultural residues – and are produced with non-conventional conversion technologies. An eligible project must use feedstocks that are or could be representative of Canadian biomass, and the technology must have been demonstrated at the pre-commercial pilot scale. SDTC will support up to 40 percent of eligible project costs.

INTERNATIONAL CO-OPERATION

NRCan co-operates with several international organizations and foreign governments in EAE program areas. Canada benefits from this co-operation by

- learning about improved ways of designing and delivering EAE programs to meet policy objectives
- working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products (in this regard, NRCan provides input, as requested, to Foreign Affairs and International Trade Canada on prospective free trade agreements and on technical barriers to trade)
- participating, along with other international partners, including the U.S. Department of Energy, in the development of an ISO[8] 50001, an Energy Management Standard that will help guide industry on best management practices and technical practices to reduce energy waste. Work on the standard started in the fall of 2008, and the expected release date is 2010.

International Energy Agency

The International Energy Agency (IEA), based in Paris, France, is an autonomous agency of the Organisation for Economic Co-operation and Development. The IEA runs a comprehensive program of energy co-operation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and co-operating on the development of rational energy programs incorporating energy security, economic development and environmental protection. The IEA and its governing board are assisted in their work by several standing groups

[8] International Organization for Standardization.

and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Co-operation (SLT) is the key committee on the policy side. The Group analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil, and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The SLT's Energy Efficiency Working Party (EEWP) provides advice on and direction to the IEA's work on specific energy efficiency issues. The OEE represents Canada on the EEWP.

Canada's international energy research and development (R&D) objectives are mainly advanced through the IEA's working parties, implementing agreements and the Committee for Energy Research and Technology. Canada participates in 11 of the IEA's 40 implementing agreements on R&D collaboration programs. NRCan spent $738,000 on IEA implementing agreements in 2008–2009, in addition to personnel and travel expenditures. In many programs, this work has helped to accelerate technology development in Canada, generating benefits that far outweigh the direct costs of collaboration.

Canada also co-operates with research centres in member countries on several R&D and technology agreements and programs. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities. These activities include participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

Group of Eight

At the Group of Eight (G8) summit in 2007 in Heiligendamm, Germany, the leaders of the G8 countries and Brazil, China, India, Mexico and South Africa agreed to initiate a topic-driven dialogue under the "Heiligendamm Process." The Process has four pillars, and working groups have been formed around each one.

Energy, with a special focus on energy efficiency, is one of the pillars. The Energy Working Group has explored the common ground available for building international support for new ideas and approaches for increasing energy efficiency. It has focused on energy security, development of a sustainable buildings network, energy efficiency in existing power plants, and alternative sources of energy and renewable energy. Canada, represented by the OEE, is co-chair with India. The Working Group met twice in 2008–2009.

NRCan facilitated the development of the agreement for an International Partnership on Energy Efficiency Cooperation (IPEEC), which was initiated by the European Union in June 2007, during the Heiligendamm Summit and finalized in 2008, during the Japanese G8 presidency. The partnership will support the on-going energy efficiency work of the participating countries and relevant international organizations. The IPEEC members will also develop public-private partnerships for improving energy efficiency.

Asia-Pacific Economic Cooperation

At the 2007 Asia-Pacific Economic Cooperation (APEC) Economic Leaders' Meeting, leaders highlighted the importance of improving energy efficiency in the Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development. The declaration endorsed an APEC-wide regional aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year).

The OEE is a member of the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C), which reports to APEC's Energy Working Group. One of the tasks of the EGEE&C is updating and maintaining the APEC Energy Standards Information System (ESIS). ESIS provides public, up-to-date information on appliance and equipment energy standards and regulations. It also provides links to experts and information related to standards and regulations used by APEC and other economies. NRCan contributes regularly to the database by providing updated information on Canadian equipment standards and labelling and new initiatives, such as the phase-out of incandescent lamps.

The OEE also participates through the Asia Pacific Partnership on Clean Development on a Task Force on Standby Power data in order to internationally coordinate its efforts to reduce standby power consumption.

Asia Pacific Partnership

CanmetENERGY participates in the Asia Pacific Partnership (APP) on four Task Forces: the Buildings and Appliances Task Force (BATF), the Renewable Energy and Distributed Power Generation Task Force (REDGTF), the Cleaner Fossil Energy Task Force and the Power Generation and Distribution Task Force.

Within the BATF and REDGTF, CanmetENERGY proposed the Net Zero Energy Homes (NZEH) initiative. Under this initiative, Canadian delegates will initiate a collaborative dialogue with BATF and REDGTF partners to establish a formal international partnership that will map the path to achieving NZEH.

Through a series of workshops and design charettes, Canada will offer APP member countries an opportunity to set a precedent for housing performance optimization by bringing together the fragmented supply chain to discuss issues facing the sector. Participation from the project leaders of the existing BATF and REDGTF projects will ensure synergies. The workshops will prominently feature the Canadian industry, case studies, R&D and demonstrations, potentially leading to commercial and technology transfer opportunities for Canadian firms.

United Nations

RETScreen® International is managed under the leadership of NRCan's CanmetENERGY Varennes (QC) Research Centre. RETScreen is managed through cost- and task-shared collaborative ventures with other governments and multilateral organizations, and with technical support from more than 300 experts representing industry, government and academia.

Key partners are NASA's Langley Research Center and the Renewable Energy and Energy Efficiency Partnership. Other key international partners include the Energy Branch of the United Nations Environment Programme (UNEP) and the UNEP Solar and Wind Energy Resource Assessment, which is sponsored by the Global Environment Facility.

Mexico

NRCan signed an MOU on EAE co-operation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and by fostering trade, investment, technical and other exchanges related to energy-efficient products, energy management services, and alternative energy goods and services. In October 2008, NRCan organized an energy management workshop in Mexico City, in co-operation with Mexico's National Commission for Energy Savings (CONAE).

In anticipation of future legislation in Canada and abroad that is targeted at the reduction of emissions, NRCan's Office of Energy Research

and Development funded R&D efforts to evaluate methodologies to identify opportunities for energy efficiency increases and fugitive emissions reduction.

In 2008–2009, CanmetENERGY, in collaboration with university researchers, engaged in Mexico-based activities with the national oil and gas company PEMEX, which were jointly supported by the United States Environmental Protection Agency (U.S. EPA), the International Methane to Markets (M2M) Partnership, and the government of Mexico. The outcome of these ongoing collaborative activities resulted in the Mexican government announcing an annual reduction of 13 megatonnes of carbon dioxide equivalent (CO_2e), which was based on the previous research.

United States

In September 2005, NRCan's OEE signed an MOU with the U.S. EPA to share in the common goal of achieving greater energy efficiency and reducing CO_2, particulate matter and oxides of nitrogen emissions through the work of their respective programs: ecoENERGY for Fleets (FleetSmart) and the SmartWay Transport Partnership.

These two programs use a voluntary approach with the on-road freight sector to increase energy efficiency through training, education and reporting initiatives. They are working together to harmonize program efforts in Canada and the United States.

North America

NRCan continues to participate with the United States and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency standards and co-operation on energy efficiency labelling programs. In 2008–2009, work under NAEWG primarily involved coordinating the energy sector commitment to the North American Security and Prosperity Initiative.

APPENDIX 1

Natural Resources Canada's Efficiency and Alternative Energy Initiatives and Expenditures, 2008–2009

	(millions of dollars)
Energy Efficiency and Alternative Transportation Fuels[1]	**$248.3**
ecoENERGY for Equipment	
ecoENERGY Retrofit – Homes	
ecoENERGY Retrofit – Small and Medium Organizations	
Federal Buildings Initiative	
ecoENERGY for Buildings and Houses	
ecoENERGY for Industry	
ecoENERGY for Personal Vehicles	
ecoENERGY for Fleets	
ecoENERGY for Biofuels	
National Renewable Diesel Demonstration	
National Energy Use Database	
Energy Efficiency – Energy Science and Technology[2]	**$88.3**
Clean Energy Systems for Buildings and Communities	
Clean Electric Power Generation	
Clean Energy Systems for Industry	
Environmentally Sustainable Oil and Gas Development	
Clean Transportation Energy	
Sustainable Bioenergy	
Canadian Biomass Innovation Network	
Alternative Energy – Renewable Energy Sources	**$72.2**
ecoENERGY for Renewable Heat	
ecoENERGY for Renewable Power	
Wind Power Production Incentive[3]	
Initiative to Purchase Electricity From Emerging Renewable Energy Sources[4]	
Total	**$408.8**

[1] The Energy Efficiency and Alternative Transportation Fuels total does not include the Sustainable Development Technology Canada – NextGen Biofuels Fund™. For details on this fund, see the text box on page 66.

[2] Totals allocated for the Program of Energy Research and Development and the ecoENERGY Technology Initiative in Chapter 4 are reflected in the relevant program entries.

[3] The Wind Power Production Incentive is fully committed, but incentives will be paid to recipients until 2016–2017.

[4] The Initiative to Purchase Electricity From Emerging Rewewable Sources is fully committed, but incentives will be paid until 2011–2012.

APPENDIX 2

Data Presented in the Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply and Demand in Canada* (RESD). Some modifications to the original Statistics Canada data were required and are documented in Appendix A of NRCan's *Energy Use Data Handbook, 1990 and 1997 to 2006*. The differences that exist between this report and Canada's *Energy Outlook* relate to the sector allocations of RESD energy-use data.

FIGURE 1-1: Secondary Energy Use by Sector, 2006

Sector	Industrial	Transportation	Residential	Commercial/ Institutional	Agriculture	Total
Energy use (PJ)	3271	2492	1347	1093	210.8	8413.8
Percentage	0.389	0.296	0.160	0.130	0.025	1.000

FIGURE 1-2: GHG Emissions From Secondary Energy Use by Sector, 2006

Sector	Transportation	Industrial	Residential	Commercial/ Institutional	Agriculture	Total
GHG emissions (Mt)	172.4	161.5	69.6	60.4	14.5	478.4
Percentage	0.360	0.338	0.145	0.126	0.030	1.00

FIGURE 1-3: Energy Intensity and the Energy Efficiency Effect, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Energy intensity index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.97	0.91	0.89	0.87	0.84	0.85	0.85	0.84	0.81	0.78
Index of energy efficiency effect	1.00	0.98	0.97	0.96	0.96	0.92	0.93	0.91	0.89	0.87	0.87	0.86	0.87	0.88	0.87	0.84	0.84

FIGURE 1-4: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated secondary energy use without energy efficiency improvements	1.00	1.00	1.03	1.05	1.09	1.15	1.17	1.20	1.20	1.25	1.29	1.27	1.31	1.33	1.36	1.38	1.36
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18	1.22	1.23	1.22	1.21

FIGURE 1-5: Canadian Households by Type of Dwelling, 2006

Dwelling type	Number of households	Percentage
Single detached homes	7 181 000	56
Single attached homes	1 346 000	11
Apartments	3 981 000	31
Mobile homes	248 000	2
Total	**12 756 000**	**100**

FIGURE 1-6: Residential Energy Use by End-Use, 2006

Activity	Energy use (PJ)	Percentage
Space heating	794.0	59
Water heating	247.4	18
Appliances	205.4	15
Lighting	69.9	5
Space cooling	30.6	2
Total	**1347.3**	**100**

FIGURE 1-7: Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Number of households	1.00	1.03	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.29
Average floor space by household	1.00	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04
Energy intensity (GJ/household)	1.00	0.96	0.97	0.98	0.98	0.95	1.01	0.96	0.86	0.88	0.91	0.86	0.89	0.91	0.88	0.86	0.81

FIGURE 1-8: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.14	1.18	1.25	1.22	1.28	1.32	1.32	1.34	1.31
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.12	1.08	0.99	1.03	1.08	1.04	1.08	1.12	1.10	1.09	1.05

FIGURE 1-9: Annual Heating* Consumption for Houses Constructed to Different Standards

House type	ecoENERGY Retrofit Homes annual heating* consumption (GJ)	Sample size	Total consumption (GJ)
Typical existing house** (1970)	146	8661	177.9
Model National Energy Code house*** (2002)	112	1	143.34
Average** of EnerGuide labelled houses (2007)	89	3992	120.68
Average** of R-2000 certified houses	76	520	107.05

*DHW and space heating
**National average
***198-m^2, two storey, single detached house heated with natural gas in Ottawa, Ontario

FIGURE 1-10: Average Energy Consumption of New Electric Appliances, 1990 and 2006 Models

Appliance	1990 models (kWh/yr)	2006 models (kWh/yr)
Clothes washers	1218	390
Clothes dryers	1103	905
Dishwashers	841	305
Refrigerators	956	481
Electric ranges	772	537
Freezers	714	380

FIGURE 1-11: Commercial/Institutional Energy Use by Activity Type,* 2006

Activity type	Energy use (PJ)	Percentage
Offices**	381.2	35
Retail trade	179.2	17
Educational services	149.9	14
Health care and social assistance	103.2	9
Accommodation and food services	83.9	7
Wholesale trade	61.3	6
Transportation and warehousing	46.8	5
Arts, entertainment and recreation	33.0	3
Information and cultural industries	25.9	2
Other services	19.9	2
Total	**1084.3**	**100**

*Excludes street lighting
**"Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 1-12: Commercial/Institutional Energy Use by Purpose, 2006

Purpose	Energy use (PJ)	Percentage
Space heating	537.4	49
Auxiliary equipment	177.4	16
Lighting	107.5	10
Space cooling	77.1	7
Water heating	95.2	9
Auxiliary motors	89.5	8
Street lighting	8.4	1
Total	**1092.5**	**100**

FIGURE 1-13: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.14	1.16	1.20	1.20	1.17	1.22	1.26	1.26	1.34	1.36	1.36	1.42	1.39
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35	1.33	1.26

FIGURE 1-14: Industrial Energy Use by Subsector – Including Electricity Related Emissions,* 2006

Subsector	Industrial energy use (%)	Energy use (PJ)
Pulp and paper	25	823.7
Mining	22	715.6
Other manufacturing**	17	554.0
Petroleum refining	10	314.5
Smelting and refining	8	267.1
Iron and steel	7	238.9
Chemicals	6	202.8
Other industries***	3	82.2
Cement	2	71.7
Total	**100**	**3270.5**

*The Subsectors below reflect the current definitions in the *Report on Energy Supply and Demand in Canada*.
**"Other manufacturing" comprises more than 20 manufacturing industries.
***"Other industries" includes construction and forestry.

FIGURE 1-15: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2006

Industry	Energy cost of total production cost
	(%)
Transportation equipment and manufacturing	0.88
Petroleum refining	2.00
Chemicals	10.65
Iron and steel	14.75
Pulp and paper	14.88
Aluminum	22.36
Cement	36.58

FIGURE 1-16: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

Index (1990 = 1.00)	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated energy use without energy efficiency improvements	1.00	1.14	1.14	1.18	1.19	1.24	1.28	1.24	1.28	1.29	1.31	1.31	1.30
Actual energy use	1.00	1.08	1.11	1.10	1.08	1.11	1.15	1.10	1.16	1.20	1.20	1.18	1.20

FIGURE 1-17: Transportation Energy Use by Mode, 2006

	Energy use (PJ)	Percentage
Passenger light vehicle	1065.3	
Passenger aviation	248.6	
Passenger bus	53.3	
Passenger rail	2.5	
Passenger total	**1369.7**	**55.1**
Freight aviation	7.1	
Freight truck	833.1	
Freight marine	99.5	
Freight rail	78.9	
Freight total	**1018.6**	**41.0**
Off-road total	**97.4**	**3.9**
Total transportation energy use	**2485.7**	**100.0**

FIGURE 1-18: Market Shares of New Passenger Car and Light-Truck Sales, 1990 to 2006

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Passenger car	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.7	59.1	60.9	63.0	63.4	62.7	62.1	61.58	61.59	61.16
Passenger light truck	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.3	40.9	39.1	37.0	36.6	37.3	37.9	38.42	38.41	38.84

FIGURE 1-19: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.05	1.12	1.15	1.18	1.23	1.27	1.32	1.34	1.36	1.38	1.41	1.48	1.50	1.51
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31	1.33	1.33

FIGURE 1-20: Average Activity per Truck, 1990 to 2006 (tonne kilometres/truck)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Medium- and heavy-duty truck vehicle activity	105 742	98 658	103 459	117 687	133 653	142 910	141 219	163 975	162 926	175 266	178 269	198 998	197 396	202 326	219 262	230 890	227 689

FIGURE 1-21: Trucking Energy Intensity, 1990 to 2006 (megajoules/tonne kilometre)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Medium- and heavy-duty trucks energy intensity	3.71	3.81	3.79	3.62	3.44	3.46	3.41	3.33	3.16	2.99	3.02	2.83	2.80	2.92	2.86	2.78	2.75

FIGURE 1-22: Shares of On-Road Transportation Fuel, 2006

Fuel type	Energy use (PJ)	Percentage
Electricity	3.5	0.16
Natural gas	1.9	0.09
Motor gasoline	1397.5	63.41
Diesel	782.9	35.52
Liquefied petroleum gas	11.6	0.53
Renewable fuels	6.4	0.29
Total	**2203.8**	**100**

FIGURE 2-1: Volume of Monthly Import Documents

Month	Paper	Electronic	Total
Apr. 08	153	113 257	113 410
May 08	362	113 315	113 677
Jun. 08	36	114 626	114 662
Jul. 08	21	122 532	122 553
Aug. 08	113	120 145	120 258
Sep. 08	1	119 302	119 303
Oct. 08	36	127 613	127 649
Nov. 08	128	106 206	106 334
Dec. 08	103	98 846	98 949
Jan. 09	311	100 555	100 866
Feb. 09	81	84 790	84 871
Mar. 09	–	94 361	94 361
Total	**1345**	**1 315 548**	**1 316 893**

FIGURE 2-4: ENERGY STAR® Qualified Appliances as a Percentage of Total Category Shipments in Canada, 1999 to 2007

Appliance	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)
Dishwashers	0.6	1.6	9.7	29.8	56.5	81.0	90.8	79.7	76.2
Clothes Washers	1.9	2.2	9.2	22.1	30.6	36.2	45.9	50.8	58.4
Refrigerators	–	–	11.4	22.3	40.7	34.2	37.6	37.3	44.3

FIGURE 2-5: ENERGY STAR® Awareness Levels in Canada, 2007

	Percentage
Aware – non-aided	56
Aware – aided	62

FIGURE 3-1: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2009

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2009*	Average
Energy use pre-renovation (GJ)	278	205	191	176	176	164	151	198
Actual energy savings after renovations (GJ)	92	55	47	42	37	31	36	51

*Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

FIGURE 3-2: Number of R-2000 Housing Certifications, 1990 to 2008

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of R-2000 houses	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	583	500	439	483	557

FIGURE 3-3: CIPEC Energy Intensity Index, 1990 to 2006

Index (1990 = 1.00)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Energy intensity index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.91	0.92	0.94	0.91	0.87	0.88

FIGURE 3-4: Industrial Dollars to $ense Participants, Pre-2000 to 2008

Fiscal year	Pre-2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of industrial workshop participants	748	408	353	481	880	1027	1290	1230	1290

FIGURE 3-5: New Vehicle Fuel Efficiency Labelling

Year	On lot	In showroom
2007	78	56
2005	78	61
2001	77	56
1999	64	47

FIGURE 3-6: Company Average Fuel Consumption (CAFC) versus Canadian Voluntary Standards, 1990 to 2007*

Truck model year	Truck standard (L/100 km)	Trucks CAFC (L/100 km)	Car standard (L/100 km)	Cars CAFC (L/100 km)
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.4	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.8
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.8	8.6	7.6
2004	11.4	10.9	8.6	7.5
2005	11.2	10.6	8.6	7.4
2006	10.9	10.4	8.6	7.4
2007	10.6	10.1	8.6	7.1

*2003–2007 data are estimates

FIGURE 4.1: RETScreen Software: Cumulative Growth of User Base

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Canada	1421	2966	4527	6650	9754	14 125	18 178	24 005	28 990	36 891	44 987
World	1688	5782	9838	15 292	20 499	27 752	38 270	56 432	78 215	110 264	148 046

FIGURE 5.1: Canadian Wind Power Capacity, 1993 to 2008

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Wind power capacity (MW)	1	22	23	23	24	27	127	139	215	233	326	445	686	1459	1846	2369

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